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The Edge Annual Question — 2006

WHAT IS YOUR DANGEROUS IDEA?

The history of science is replete with discoveries that were considered socially, morally, or emotionally dangerous in their time; the Copernican and Darwinian revolutions are the most obvious. What is your dangerous idea? An idea you think about (not necessarily one you originated) that is dangerous not because it is assumed to be false, but because it might be true?

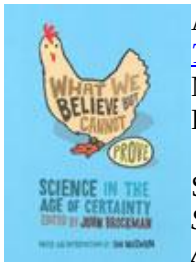
[Thanks to Steven Pinker for suggesting the *Edge* Annual Question — 2006.]

January 1, 2006

To the *Edge* Community,

Last year's 2005 *Edge* Question — "What do you believe is true even though you cannot prove it?" — generated many eye-opening responses from a "who's who" of third culture scientists and science-minded thinkers. The 120 contributions comprised a document of 60,000 words. *The New York Times* ("Science Times") and *Frankfurter Allgemeine Zeitung* ("Feuilliton") published excepts in their print and online editions simultaneously with *Edge* publication.

The event was featured across the world: BBC Radio; *Il Sole 24 Ore, Prospect, El Pais, The Financial Express* (Bangledesh), *The Sunday Times* (UK), *The Sydney Morning Herald, The Guardian, La Stampa, The Telegraph.*



A book based on the 2005 Question — *What We Believe But Cannot Prove: Today's Leading Thinkers on Science in the Age of Certainty*, with an introduction by the novelist Ian McEwan — was just published by the Free Press (UK). The US edition follows from HarperCollins in February, 2006.

Since September, *Edge* has been featured and/ or cited in *The Toronto Star, Boston Globe, Seed, Rocky Mountain Mews, Observer, El Pais, La Vanguaria, El Mundo, Frankfurter Allgemeine Zeitung, Science, Financial Times, Newsweek, AD, La Stampa, The Telegraph, Quark*, and *The Wall Street Journal.*

Something radically new is in the air: new ways of understanding physical systems, new ways of thinking about thinking that call into question many of our basic assumptions. A realistic biology of the mind, advances in evolutionary biology, physics, information technology, genetics, neurobiology, psychology, engineering, the chemistry of materials: all are questions of critical importance with respect to what it means to be human. For the first time, we have the tools and the will to undertake the scientific study of human nature.

This year, the third culture thinkers in the Edge community have written 117 original essays (a document of 72,500 words) in response to the 2006 *Edge* Question — "What is your dangerous idea?". Here you will find indications of a new natural philosophy, founded on the realization of the import of complexity, of evolution. Very complex systems — whether organisms, brains, the biosphere, or the universe itself — were not constructed by design; all have evolved. There is a new set of metaphors to describe ourselves, our minds, the universe, and all of the things we know in it.

Welcome to *Edge*. Welcome to "dangerous ideas". Happy New Year.

John Brockman
Publisher & Editor

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117 contributors [72,500 words]

CONTRIBUTORS

MARTIN REES

President, The Royal Society; Professor of Cosmology & Astrophysics, Master, Trinity College, University of Cambridge; Author, Our Final Century: The 50/ 50 Threat to Humanity's Survival

Science may be 'running out of control'

Public opinion surveys (at least in the UK) reveal a generally positive attitude to science. However, this is coupled with widespread worry that science may be 'running out of control'. This latter idea is, I think, a dangerous one, because if widely believed it could be self-fulfilling.

In the 21st century, technology will change the world faster than ever — the global environment, our lifestyles, even human nature itself. We are far more empowered by science than any previous generation was: it offers immense potential — especially for the developing world — but there could be catastrophic downsides. We are living in the first century when the greatest risks come from human actions rather than from nature.

Almost any scientific discovery has a potential for evil as well as for good; its applications can be channeled either way, depending on our personal and political choices; we can't accept the benefits without also confronting the risks. The decisions that we make, individually and collectively, will determine whether the outcomes of 21st century sciences are benign or devastating. But there's' a real danger that that, rather than campaigning energetically for optimum policies, we'll be lulled into inaction by a feeling of fatalism — a belief that science is advancing so fast, and is so much influenced by commercial and political pressures, that nothing we can do makes any difference.

The present share-out of resources and effort between different sciences is the outcome of a complicated 'tension' between many extraneous factors. And the balance is suboptimal. This seems so whether we judge in purely intellectual terms, or take account of likely benefit to human welfare. Some subjects have had the 'inside track' and gained disproportionate resources. Others, such as environmental researches, renewable energy sources, biodiversity studies and so forth, deserve more effort. Within medical research the focus is disproportionately on cancer and cardiovascular studies, the ailments that loom largest in prosperous countries, rather than on the infectious diseases endemic in the tropics.

Choices on how science is applied — to medicine, the environment, and so forth — should be the outcome of debate extending way beyond the scientific community. Far more research and development can be done than we actually want or can afford to do; and there are many applications

of science that we should consciously eschew.

Even if all the world's scientific academies agreed that a specific type of research had a specially disquieting net 'downside' and all countries, in unison, imposed a ban, what is the chance that it could be enforced effectively enough? In view of the failure to control drug smuggling or homicides, it is unrealistic to expect that, when the genie is out of the bottle, we can ever be fully secure against the misuse of science. And in our ever more interconnected world, commercial pressure are harder to control and regulate. The challenges and difficulties of 'controlling' science in this century will indeed be daunting.

Cynics would go further, and say that anything that is scientifically and technically possible will be done — somewhere, sometime — despite ethical and prudential objections, and whatever the regulatory regime. Whether this idea is true or false, it's an exceedingly dangerous one, because it's engenders despairing pessimism, and demotivates efforts to secure a safer and fairer world. The future will best be safeguarded — and science has the best chance of being applied optimally — through the efforts of people who are less fatalistic.

J. CRAIG VENTER
Genomics Researcher; Founder & President, J. Craig Venter Science Foundation

Revealing the genetic basis of personality and behavior will create societal conflicts

From our initial analysis of the sequence of the human genome, particularly with the much smaller than expected number of human genes, the genetic determinists seemed to have clearly suffered a setback. After all, those looking for one gene for each human trait and disease couldn't possibly be accommodated with as few as twenty-odd thousand genes when hundreds of thousands were anticipated. Deciphering the genetic basis of human behavior has been a complex and largely unsatisfying endeavor due to the limitations of the existing tools of genetic trait analysis particularly with complex traits involving multiple genes.

All this will soon undergo a revolutionary transformation. The rate of change of DNA sequencing technology is continuing at an exponential pace. We are approaching the time when we will go from having a few human genome sequences to complex databases containing first tens, to hundreds of thousands, of complete genomes, then millions. Within a decade we will begin rapidly accumulating the complete genetic code of humans along with the phenotypic repertoire of the same individuals. By performing multifactorial analysis of the DNA sequence variations, together with the comprehensive phenotypic information gleaned from every branch of human investigatory discipline, for the first time in history, we will be able to provide answers to quantitatively questions of what is genetic versus what is due to the environment. This is already taking place in cancer research where we can measure the

differences in genetic mutations inherited from our parents versus those acquired over our lives from environmental damage. This good news will help transform the treatment of cancer by allowing us to know which proteins need to be targeted.

However, when these new powerful computers and databases are used to help us analyze who we are as humans, will society at large, largely ignorant and afraid of science, be ready for the answers we are likely to get?

For example, we know from experiments on fruit flies that there are genes that control many behaviors, including sexual activity. We sequenced the dog genome a couple of years ago and now an additional breed has had its genome decoded. The canine world offers a unique look into the genetic basis of behavior. The large number of distinct dog breeds originated from the wolf genome by selective breeding, yet each breed retains only subsets of the wolf behavior spectrum. We know that there is a genetic basis not only of the appearance of the breeds with 30-fold difference in weight and 6-fold in height but in their inherited actions. For example border collies can use the power of their stare to herd sheep instead of freezing them in place prior to devouring them.

We attribute behaviors in other mammalian species to genes and genetics but when it comes to humans we seem to like the notion that we are all created equal, or that each child is a "blank slate". As we obtain the sequences of more and more mammalian genomes including more human sequences, together with basic observations and some common sense, we will be forced to turn away from the politically correct interpretations, as our new genomic tool sets provide the means to allow us to begin to sort out the reality about nature or nurture. In other words, we are at the threshold of a realistic biology of humankind.

It will inevitably be revealed that there are strong genetic components associated with most aspects of what we attribute to human existence including personality subtypes, language capabilities, mechanical abilities, intelligence, sexual activities and preferences, intuitive thinking, quality of memory, will power, temperament, athletic abilities, etc. We will find unique manifestations of human activity linked to genetics associated with isolated and/ or inbred populations.

The danger rests with what we already know: that we are not all created equal. Further danger comes with our ability to quantify and measure the genetic side of the equation before we can fully understand the much more difficult task of evaluating environmental components of human existence. The genetic determinists will appear to be winning again, but we cannot let them forget the range of potential of human achievement with our limiting genetic repertoire.

LEO CHALUPA
Ophthalmologist and Neurobiologist, University of California, Davis

A 24-hour period of absolute solitude

Our brains are constantly subjected to the demands of multi-tasking and a seemingly endless cacophony of information from diverse sources. Cell phones, emails, computers, and cable television are omnipresent, not to mention such archaic venues as books, newspapers and magazines.

This induces an unrelenting barrage of neuronal activity that in turn produces long-lasting structural modification in virtually all compartments of the nervous system. A fledging industry touts the virtues of exercising your brain for self-improvement. Programs are offered for how to make virtually any region of your neocortex a more efficient processor. Parents are urged to begin such regimes in preschool children and adults are told to take advantage of their brain's plastic properties for professional advancement. The evidence documenting the veracity for such claims is still outstanding, but one thing is clear. Even if brain exercise does work, the subsequent waves of neuronal activities stemming from simply living a modern lifestyle are likely to eradicate the presumed hard-earned benefits of brain exercise.

My dangerous idea is that what's needed to attain optimal brain performance — with or without prior brain exercise — is a 24-hour period of absolute solitude. By absolute solitude I mean no verbal interactions of any kind (written or spoken, live or recorded) with another human being. I would venture that a significantly higher proportion of people reading these words have tried skydiving than experienced one day of absolute solitude.

What to do to fill the waking hours? That's a question that each person would need to answer for him/ herself. Unless you've spent time in a monastery or in solitary confinement it's unlikely that you've had to deal with this issue. The only activity not proscribed is thinking. Imagine if everyone in this country had the opportunity to do nothing but engage in uninterrupted thought for one full day a year!

A national day of absolute solitude would do more to improve the brains of all Americans than any other one-day program. (I leave it to the lawmakers to figure out a plan for implementing this proposal.)The danger stems from the fact that a 24 period for uninterrupted thinking could cause irrevocable upheavals in much of what our society currently holds sacred.But whether that would improve our present state of affairs cannot be guaranteed.

V.S. RAMACHANDRAN
Neuroscientist; Director, Center for Brain and Cognition, University of California, San Diego; Author, A Brief Tour of Human Consciousness

Francis Crick's "Dangerous Idea"

I am a brain, my dear Watson, and the rest of me is a mere appendage.
— Sherlock Holmes

An idea that would be "dangerous if true" is what Francis Crick referred to as "the astonishing hypothesis"; the notion that our conscious experience and sense of self is based entirely on the activity of a hundred billion bits of jelly — the neurons that constitute the brain. We take this for granted in these enlightened times but even so it never ceases to amaze me.

Some scholars have criticized Cricks tongue-in-cheek phrase (and title of his book) on the grounds that the hypothesis he refers to is "neither astonishing nor a hypothesis". (Since we already know it to be true) Yet the far reaching philosophical, moral and ethical dilemmas posed by his hypothesis have not been recognized widely enough. It is in many ways the *ultimate* dangerous idea .

Lets put this in historical perspective.

Freud once pointed out that the history of ideas in the last few centuries has been punctuated by "revolutions" major upheavals of thought that have forever altered our view of ourselves and our place in the cosmos.

First there was the Copernican system dethroning the earth as the center of the cosmos.

Second was the Darwinian revolution; the idea that far from being the climax of "intelligent design" we are merely neotonous apes that happen to be slightly cleverer than our cousins.

Third, the Freudian view that even though you claim to be "in charge" of your life, your behavior is in fact governed by a cauldron of drives and motives of which you are largely unconscious.

And fourth, the discovery of DNA and the genetic code with its implication (to quote James Watson) that "There are only molecules. Everything else is sociology".

To this list we can now add the fifth, the "neuroscience revolution" and its corollary pointed out by Crick — the "astonishing hypothesis" — that even our loftiest thoughts and aspirations are mere byproducts of neural activity. We are nothing but a pack of neurons.

If all this seems dehumanizing, you haven't seen anything yet.

[Editor's Note: An lengthly essay by Ramachandran on this subject is scheduled for publication by

Edge in January.]

DAVID BUSS
Psychologist, University of Texas, Austin; Author, The Murderer Next Door: Why the Mind is Designed to Kill

The Evolution of Evil

When most people think of torturers, stalkers, robbers, rapists, and murderers, they imagine crazed drooling monsters with maniacal Charles Manson-like eyes. The calm normal-looking image starring back at you from the bathroom mirror reflects a truer representation. The dangerous idea is that all of us contain within our large brains adaptations whose functions are to commit despicable atrocities against our fellow humans — atrocities most would label evil.

The unfortunate fact is that killing has proved to be an effective solution to an array of adaptive problems in the ruthless evolutionary games of survival and reproductive competition: Preventing injury, rape, or death; protecting one's children; eliminating a crucial antagonist; acquiring a rival's resources; securing sexual access to a competitor's mate; preventing an interloper from appropriating one's own mate; and protecting vital resources needed for reproduction.

The idea that evil has evolved is dangerous on several counts. If our brains contain psychological circuits that can trigger murder, genocide, and other forms of malevolence, then perhaps we can't hold those who commit carnage responsible: "It's not my client's fault, your honor, his evolved homicide adaptations made him do it." Understanding causality, however, does not exonerate murderers, whether the tributaries trace back to human evolution history or to modern exposure to alcoholic mothers, violent fathers, or the ills of bullying, poverty, drugs, or computer games. It would be dangerous if the theory of the evolved murderous mind were misused to let killers free.

The evolution of evil is dangerous for a more disconcerting reason. We like to believe that evil can be objectively located in a particular set of evil deeds, or within the subset people who perpetrate horrors on others, regardless of the perspective of the perpetrator or victim. That is not the case. The perspective of the perpetrator and victim differ profoundly. Many view killing a member of one's in-group, for example, to be evil, but take a different view of killing those in the out-group. Some people point to the biblical commandment "thou shalt not kill" as an absolute. Closer biblical inspection reveals that this injunction applied only to murder within one's group.

Conflict with terrorists provides a modern example. Osama bin Laden declared: "The ruling to kill the Americans and their allies — civilians and military — is an individual duty for every Muslim who can do it in any country in which it is possible to do it." What is evil from the perspective of an American who is a potential victim is an act of responsibility and higher moral good from the terrorist's

perspective. Similarly, when President Bush identified an "axis of evil," he rendered it moral for Americans to kill those falling under that axis — a judgment undoubtedly considered evil by those whose lives have become imperiled.

At a rough approximation, we view as evil people who inflict massive evolutionary fitness costs on us, our families, or our allies. No one summarized these fitness costs better than the feared conqueror Genghis Khan (1167-1227): "The greatest pleasure is to vanquish your enemies, to chase them before you, to rob them of their wealth, to see their near and dear bathed in tears, to ride their horses and sleep on the bellies of their wives and daughters."

We can be sure that the families of the victims of Genghis Khan saw him as evil. We can be just as sure that his many sons, whose harems he filled with women of the conquered groups, saw him as a venerated benefactor. In modern times, we react with horror at Mr. Khan describing the deep psychological satisfaction he gained from inflicting fitness costs on victims while purloining fitness fruits for himself. But it is sobering to realize that perhaps half a percent of the world's population today are descendants of Genghis Khan.

On reflection, the dangerous idea may not be that murder historically has been advantageous to the reproductive success of killers; nor that we all house homicidal circuits within our brains; nor even that all of us are lineal descendants of ancestors who murdered. The danger comes from people who refuse to recognize that there are dark sides of human nature that cannot be wished away by attributing them to the modern ills of culture, poverty, pathology, or exposure to media violence. The danger comes from failing to gaze into the mirror and come to grips the capacity for evil in all of us.

PAUL BLOOM
Psychologist, Yale University; Author, Descartes' Baby

There are no souls

I am not concerned here with the radical claim that personal identity, free will, and consciousness do not exist. Regardless of its merit, this position is so intuitively outlandish that nobody but a philosopher could take it seriously, and so it is unlikely to have any real-world implications, dangerous or otherwise.

Instead I am interested in the milder position that mental life has a purely material basis. The dangerous idea, then, is that Cartesian dualism is false. If what you mean by "soul" is something immaterial and immortal, something that exists independently of the brain, then souls do not exist. This is old hat for most psychologists and philosophers, the stuff of introductory lectures. But the

rejection of the immaterial soul is unintuitive, unpopular, and, for some people, downright repulsive.

In the journal "First Things", Patrick Lee and Robert P. George
outline some worries from a religious perspective.

"If science did show that all human acts, including conceptual thought and free choice, are just brain processes,... it would mean that the difference between human beings and other animals is only superficial-a difference of degree rather than a difference in kind; it would mean that human beings lack any special dignity worthy of special respect. Thus, it would undermine the norms that forbid killing and eating human beings as we kill and eat chickens, or enslaving them and treating them as beasts of burden as we do horses or oxen."

The conclusions don't follow. Even if there are no souls, humans might differ from non-human animals in some other way, perhaps with regard to the capacity for language or abstract reasoning or emotional suffering. And even if there were no difference, it would hardly give us license to do terrible things to human beings. Instead, as Peter Singer and others have argued, it should make us kinder to non-human animals. If a chimpanzee turned out to possess the intelligence and emotions of a human child, for instance, most of us would agree that it would be wrong to eat, kill, or enslave it.

Still, Lee and George are right to worry that giving up on the soul means giving up on a priori distinction between humans and other creatures, something which has very real consequences. It would affect as well how we think about stem-cell research and abortion, euthenasia, cloning, and cosmetic psychopharmacology. It would have substantial implications for the legal realm — a belief in immaterial souls has led otherwise sophisticated commentators to defend a distinction between actions that we do and actions that our brains do. We are responsible only for the former, motivating the excuse that Michael Gazzaniga has called, "My brain made me do it." It has been proposed, for instance, that if a pedophile's brain shows a certain pattern of activation while contemplating sex with a child, he should not be viewed as fully responsible for his actions. When you give up on the soul, and accept that all actions correspond to brain activity, this sort of reasoning goes out the window.

The rejection of souls is more dangerous than the idea that kept us so occupied in 2005 — evolution by natural selection. The battle between evolution and creationism is important for many reasons; it is where science takes a stand against superstition. But, like the origin of the universe, the origin of the species is an issue of great intellectual importance and little practical relevance. If everyone were to become a sophisticated Darwinian, our everyday lives would change very little. In contrast, the widespread rejection of the soul would have profound moral and legal consequences. It would also require people to rethink what happens when they die, and give up the idea (held by about 90% of Americans) that their souls will survive the death of their bodies and ascend to heaven. It is hard to get more dangerous than that.

PAUL W. EWALD
Evolutionary Biologist; Director, Program in Evolutionary Medicine, University of Louisville; Author, Plague Time

A New Golden Age of Medicine

My dangerous idea is that we have in hand most of the information we need to facilitate a new golden age of medicine. And what we don't have in hand we can get fairly readily by wise investment in targeted research and intervention. In this golden age we should be able to prevent most debilitating diseases in developed and undeveloped countries within a relatively short period of time with much less money than is generally presumed. This is good news. Why is it dangerous?

One array of dangers arises because ideas that challenge the status quo threaten the livelihood of many. When the many are embedded in powerful places the threat can be stifling, especially when a lot of money and status are at stake. So it is within the arena of medical research and practice. Imagine what would happen if the big diseases — cancers, arteriosclerosis, stroke, diabetes — were largely prevented.

Big pharmas would become small because the demand for prescription drugs would drop. The prestige of physicians would drop because they would no longer be relied upon to prolong life. The burgeoning industry of biomedical research would shrink because governmental and private funding for this research would diminish. Also threatened would be scientists whose sense of self-worth is built upon the grant dollars they bring in for discovering miniscule parts of big puzzles. Scientists have been beneficiaries of the lack of progress in recent decades, which has caused leaders such as the past head of NIH, Harold Varmus, to declare that what is needed is more basic research. But basic research has not generated many great advancements in the prevention or cure of disease in recent decades.

The major exception is in the realm of infectious disease where many important advancements were generated from tiny slices of funding. The discovery that peptic ulcers are caused by infections that can be cured with antibiotics is one example. Another is the discovery that liver cancer can often be prevented by a vaccine against the hepatitis B virus or by screening blood for hepatitis B and C viruses.

The track record of the past few decades shows that these examples are not quirks. They are part of a trend that goes back over a century to the beginning of the germ theory itself. And the accumulating evidence supporting infectious causation of big bad diseases of modern society is following the same pattern that occurred for diseases that have been recently accepted as caused by infection.

The process of acceptance typically occurs over one or more decades and accords with Schopenhauer's generalization about the establishment of truth: it is first ridiculed, then violently opposed, and finally accepted as being self-evident. Just a few groups of pathogens seem to be big players: streptococci, *Chlamydia*, some bacteria of the oral cavity, hepatitis viruses, and herpes viruses. If the correlations between these pathogens and the big diseases of wealthy countries does in fact reflect infectious causation, effective vaccines against these pathogens could contribute in a big way to a new golden age

of medicine that could rival the first half of the 20th century.

The transition to this golden age, however, requires two things: a shift in research effort to identifying the pathogens that cause the major diseases and development of effective interventions against them. The first would be easy to bring about by restructuring the priorities of NIH — where money goes, so go the researchers. The second requires mechanisms for putting in place programs that cannot be trusted to the free market for the same kinds of reasons that Adam Smith gave for national defense. The goals of the interventions do not mesh nicely with the profit motive of the free market. Vaccines, for example, are not very profitable.

Pharmas cannot make as much money by selling one vaccine per person to prevent a disease as they can selling a patented drug like Vioxx which will be administered day after day, year after year to treat symptoms of an illness that is never cured. And though liability issues are important for such symptomatic treatment, the pharmas can argue forcefully that drugs with nasty side effects provide some benefit even to those who suffer most from the side effects because the drugs are given not to prevent an illness but rather to people who already have an illness. This sort of defense is less convincing when the victim is a child who developed permanent brain damage from a rare complication of a vaccine that was given to protect them against a chronic illness that they might have acquired decades later.

Another part of this vision of a new golden age will be the ability to distinguish real threats from pseudo-threats. This ability will allow us to invest in policy and infrastructure that will protect people against real threats without squandering resources and destroying livelihoods in efforts to protect against pseudo-threats. Our present predicament on this front is far from this ideal.

Today experts on infectious diseases and institutions entrusted to protect and improve human health sound the alarm in response to each novel threat. The current fears over a devastating pandemic of bird flu is a case in point. Some of the loudest voices offer a simplistic argument: failing to prepare for the worst-case scenarios is irresponsible and dangerous. This criticism has been recently leveled at me and others who question expert proclamations, such as those from the World Health Organization and the Centers for Disease Control.

These proclamations inform us that H5N1 bird flu virus poses an imminent threat of an influenza pandemic similar to or even worse than the 1918 pandemic. I have decreased my popularity in such circles by suggesting that the threat of this scenario is essentially nonexistent. In brief I argue that the 1918 influenza viruses evolved their unique combination of high virulence and high transmissibility in the conditions at the Western Front of World War I.

By transporting contagious flu patients into a series of tightly packed groups of susceptible individuals, personnel fostered transmission from people who were completely immobilized by their illness. Such conditions must have favored the predator-like variants of the influenza virus; these variants would have a competitive edge because they could ruthlessly exploit a person for their own replication and still get transmitted to large numbers of susceptible individuals.

These conditions have not recurred in human populations since then and, accordingly, we have never had any outbreaks of influenza viruses that have been anywhere near as harmful as those that emerged

at the Western Front. So long as we do not allow such conditions to occur again we have little to fear from a reevolution of such a predatory virus.

The fear of a 1918 style pandemic has fueled preparations by a government which, embarrassed by its failure to deal adequately with the damage from Katrina, seems determined to prepare for any perceived threat to save face. I would have no problem with the accusation of irresponsibility if preparations for a 1918 style pandemic were cost free. But they are not.

The $7 billion that the Bush administration is planning as a downpayment for pandemic preparedness has to come from somewhere. If money is spent to prepare for an imaginary pandemic, our progress could be impeded on other fronts that could lead to or have already established real improvements in public health.

Conclusions about responsibility or irresponsibility of this argument require that the threat from pandemic influenza be assessed relative to the damage that results from the procurement of the money from other sources. The only reliable evidence of the damage from pandemic influenza under normal circumstances is the experience of the two pandemics that have occurred since 1918, one in 1957 and the other in 1968. The mortality caused by these pandemics was one-tenth to one-hundredth the death toll from the 1918 pandemic.

We do need to be prepared for an influenza pandemic of the normal variety, just as we needed to be prepared for category 5 hurricanes in the Gulf of Mexico. If possible our preparations should allow us to stop an incipient pandemic before it materializes. In contrast with many of the most vocal experts I do not conclude that our surveillance efforts will be quickly overwhelmed by a highly transmissible descendent of the influenza virus that has generated the most recent fright (dubbed H5N1). The transition of the H5N1 virus to a pandemic virus would require evolutionary change.

The dialogue on this matter, however, continues to neglect the primary mechanism of the evolutionary change: natural selection. Instead it is claimed that H5N1 could mutate to become a full-fledged human virus that is both highly transmissible and highly lethal. Mutation provides only the variation on which natural selection acts. We must consider natural selection if we are to make meaningful assessments of the danger posed by the H5N1 virus.

The evolution of the 1918 virus was gradual, and both evidence and theory lead to the conclusion that any evolution of increased transmissibility of H5N1 from human to human will be gradual, as it was with SARS. With surveillance we can detect such changes in humans and intervene to stop further spread as was done with SARS. We do not need to trash the economy of southeast asia each year to accomplish this.

The dangerous vision of a golden age does not leave the poor countries behind. As I have discussed in my articles and books, we should be able to control much of the damage caused by the major killers in poor countries by infrastructural improvements that not only reduce the frequency of infection but also cause the infectious agents to evolve toward benignity.

This integrated approach offers the possibility to remodel our current efforts against the major killers — AIDS, malaria, tuberculosis, dysentery and the like. We should be able to move from just holding

ground to institution of the changes that created the freedom from acute infectious diseases that have been enjoyed by inhabitants of rich countries over the past century.

Dangerous indeed! Excellent solutions are often dangerous to the status quo because they they work. One measure of danger to some but success to the general population is the extent to which highly specialized researchers, physicians, and other health care workers will need to retrain, and the extent to which hospitals and pharmaceutical companies will need to downsize. That is what happens when we introduce excellent solutions to health problems. We need not be any more concerned about these difficulties than the loss of the iron lung industry and the retraining of polio therapists and researchers in the wake of the Salk vaccine.

BART KOSKO
Professor, Electrical Engineering, USC; Author, Heaven in a Chip

Most bell curves have thick tails

Any challenge to the normal probability bell curve can have far-reaching consequences because a great deal of modern science and engineering rests on this special bell curve. Most of the standard hypothesis tests in statistics rely on the normal bell curve either directly or indirectly. These tests permeate the social and medical sciences and underlie the poll results in the media. Related tests and assumptions underlie the decision algorithms in radar and cell phones that decide whether the incoming energy blip is a 0 or a 1. Management gurus exhort manufacturers to follow the "six sigma" creed of reducing the variance in products to only two or three defective products per million in accord with "sigmas" or standard deviations from the mean of a normal bell curve. Models for trading stock and bond derivatives assume an underlying normal bell-curve structure. Even the quantum uncertainty principles involve the normal bell curve. Indeed the "uncertainty" in the principles is that the bell of one bell curve of one variable gets wider as the corresponding bell of another bell curve of another variable gets narrower. So increasing the certainty of a car's velocity on a straight road implies less certainty about the car's position and vice versa. Deviating even slightly from the normal bell curve can sometimes produce qualitatively different results.

The proposed dangerous idea stems from two facts about the normal bell curve.

First: The normal bell curve is not the only bell curve. There are at least as many different bell curves as there are real numbers. This simple mathematical fact poses at once a grammatical challenge to the title of Charles Murray's IQ book *The Bell Curve*. Murray should have used the indefinite article "A" instead of the definite article "The." This is but one of many examples that

suggest that most scientists simply equate the entire infinite set of probability bell curves with the normal bell curve of textbooks. Nature need not share the same practice. Human and non-human behavior can be far more diverse than the classical normal bell curve allows.

Second: The normal bell curve is a skinny bell curve. It puts most of its probability mass in the main lobe or bell while the tails quickly taper off exponentially. So "tail events" appear rare simply as an artifact of this bell curve's mathematical structure. This limitation may be fine for approximate descriptions of "normal" behavior near the center of the distribution. But it largely rules out or marginalizes the wide range of phenomena that take place in the tails.

Again most bell curves have thick tails. Rare events are not so rare if the bell curve has thicker tails than the normal bell curve has. Telephone interrupts are more frequent. Lightning flashes are more frequent and more energetic. Stock market fluctuations or crashes are more frequent. How much more frequent they are depends on how thick the tail is—and that is always an *empirical* question of fact. Neither logic nor assume-the-normal-curve habit can answer the question. Instead scientists need to carry their evidentiary burden a step further and apply one of the many available statistical tests to determine and distinguish the bell-curve thickness.

One response to this call for tail-thickness sensitivity is that logic alone can decide the matter because of the so-called central limit theorem of classical probability theory. This important "central" result states that some suitably normalized sums of random terms will converge to a standard normal random variable and thus have a normal bell curve in the limit. So Gauss and a lot of other long-dead mathematicians got it right after all and thus we can continue to assume normal bell curves with impunity.

That argument fails in general for two reasons.

The first reason it fails is that the classical central limit theorem result rests on a critical assumption that need not hold and that often does not hold in practice. The theorem assumes that the random dispersion about the mean is so comparatively slight that a particular measure of this dispersion—the variance or the standard deviation—is finite or does not blow up to infinity in a mathematical sense. Most bell curves have infinite or undefined variance even though they have a finite dispersion about their center point. The error is not in the bell curves but in the two-hundred-year-old assumption that variance equals dispersion. It does not in general. Variance is a convenient but artificial and non-robust measure of dispersion. It tends to overweight "outliers" in the tail regions because the variance squares the underlying errors between the values and the mean. Such squared errors simplify the math but produce the infinite effects. These effects do not appear in the classical central limit theorem because the theorem assumes them away.

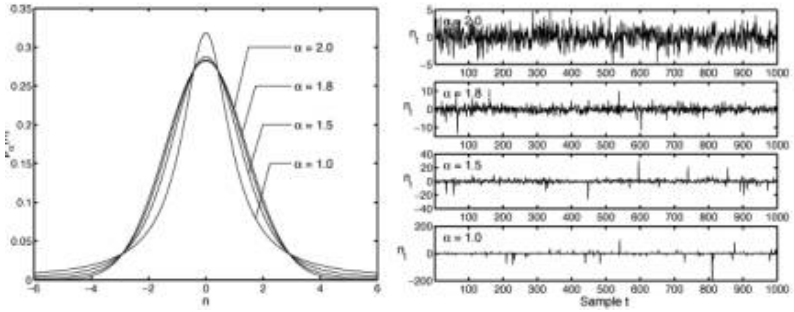
The second reason the argument fails is that the central limit theorem itself is just a special case of a more general result called the generalized central limit theorem. The generalized central limit theorem yields convergence to thick-tailed bell curves in the general case. Indeed it yields convergence to the thin-tailed normal bell curve only in the special case of finite variances. These general cases define the infinite set of the so-called *stable* probability distributions and their symmetric versions are bell curves. There are still other types of thick-tailed bell curves (such as the Laplace bell curves used in image processing and elsewhere) but the stable bell

curves are the best known and have several nice mathematical properties. The figure below shows the normal or Gaussian bell curve superimposed over three thicker-tailed stable bell curves. The catch in working with stable bell curves is that their mathematics can be nearly intractable. So far we have closed-form solutions for only two stable bell curves (the normal or Gaussian and the very-thick-tailed Cauchy curve) and so we have to use transform and computer techniques to generate the rest. Still the exponential growth in computing power has long since made stable or thick-tailed analysis practical for many problems of science and engineering.

This last point shows how competing bell curves offer a new context for judging whether a given set of data reasonably obey a normal bell curve. One of the most popular eye-ball tests for normality is the PP or probability plot of the data. The data should almost perfectly fit a straight line if the data come from a normal probability distribution. But this seldom happens in practice. Instead real data snake all around the ideal straight line in a PP diagram. So it is easy for the user to shrug and a call any data deviation from the ideal line good enough in the absence of a direct bell-curve competitor. A fairer test is to compare the normal PP plot with the best-fitting thick-tailed or stable PP plot. The data may well line up better in a thick-tailed PP diagram than it does in the usual normal PP diagram. This test evidence would reject the normal bell-curve hypothesis in favor of the thicker-tailed alternative. Ignoring these thick-tailed alternatives favors accepting the less-accurate normal bell curve and thus leads to underestimating the occurrence of tail events.

Stable or thick-tailed probability curves continue to turn up as more scientists and engineers search for them. They tend to accurately model impulsive phenomena such as noise in telephone lines or in the atmosphere or in fluctuating economic assets. Skewed versions appear to best fit the data for the Ethernet traffic in bit packets. Here again the search is ultimately an empirical one for the best-fitting tail thickness. Similar searches will only increase as the math and software of thick-tailed bell curves work their way into textbooks on elementary probability and statistics. Much of it is already freely available on the Internet.

Thicker-tail bell curves also imply that there is not just a single form of pure white noise. Here too there are at least as many forms of white noise (or any colored noise) as there are real numbers. Whiteness just means that the noise spikes or hisses and pops are independent in time or that they do not correlate with one another. The noise spikes themselves can come from any probability distribution and in particular they can come from any stable or thick-tailed bell curve. The figure below shows the normal or Gaussian bell curve and three kindred thicker-tailed bell curves and samples of their corresponding white noise. The white noise from the thicker-tailed bell curves becomes much more impulsive as their bell narrows and their tails thicken because then more extreme events or noise spikes occur with greater frequency.



Competing bell curves: The figure on the left shows four superimposed symmetric alpha-stable bell curves with different tail thicknesses while the plots on the right show samples of their corresponding forms of white noise. The parameter α describes the thickness of a stable bell curve and ranges from 0 to 2. Tails grow thicker as α grows smaller. The white noise grows more impulsive as the tails grow thicker. The Gaussian or normal bell curve $(\alpha = 2)$ has the thinnest tail of the four stable curves while the Cauchy bell curve $(\alpha = 1)$ has the thickest tails and thus the most impulsive noise. Note the different magnitude scales on the vertical axes. All the bell curves have finite dispersion while only the Gaussian or normal bell curve has a finite variance or finite standard deviation.

My colleagues and I have recently shown that most mathematical models of spiking neurons in the retina can not only benefit from small amounts of added noise by increasing their Shannon bit count but they still continue to benefit from added thick-tailed or "infinite-variance" noise. The same result holds experimentally for a carbon nanotube transistor that detects signals in the presence of added electrical noise.

Thick-tailed bell curves further call into question what counts as a statistical "outlier" or bad data: Is a tail datum error or pattern? The line between extreme and non-extreme data is not just fuzzy but depends crucially on the underlying tail thickness.

The usual rule of thumb is that the data is suspect if it lies outside three or even two standard deviations from the mean. Such rules of thumb reflect both the tacit assumption that dispersion equals variance and the classical central-limit effect that large data sets are not just approximately bell curves but approximately thin-tailed normal bell curves. An empirical test of the tails may well justify the latter thin-tailed assumption in many cases. But the mere assertion of the normal bell curve does not. So "rare" events may not be so rare after all.

MATT RIDLEY
Science Writer; Founding chairman of the International Centre for Life; Author, The Agile Gene: How Nature Turns on Nature

Government is the problem not the solution

In all times and in all places there has been too much government. We now know what prosperity is: it is the gradual extension of the division of labour through the free exchange of goods and ideas, and the consequent introduction of efficiencies by the invention of new technologies. This is the process that has given us health, wealth and wisdom on a scale unimagined by our ancestors. It not only raises material standards of living, it also fuels social integration, fairness and charity. It has never failed yet. No society has grown poorer or more unequal through trade, exchange and invention. Think of pre-Ming as opposed to Ming China, seventeenth century Holland as opposed to imperial Spain, eighteenth century England as opposed to Louis XIV's France, twentieth century America as opposed to Stalin's Russia, or post-war Japan, Hong Kong and Korea as opposed to Ghana, Cuba and Argentina. Think of the Phoenicians as opposed to the Egyptians, Athens as opposed to Sparta, the Hanseatic League as opposed to the Roman Empire. In every case, weak or decentralised government, but strong free trade led to surges in prosperity for all, whereas strong, central government led to parasitic, tax-fed officialdom, a stifling of innovation, relative economic decline and usually war.

Take Rome. It prospered because it was a free trade zone. But it repeatedly invested the proceeds of that prosperity in too much government and so wasted it in luxury, war, gladiators and public monuments. The Roman empire's list of innovations is derisory, even compared with that of the 'dark ages' that followed.

In every age and at every time there have been people who say we need more regulation, more government. Sometimes, they say we need it to protect exchange from corruption, to set the standards and police the rules, in which case they have a point, though often they exaggerate it. Self-policing standards and rules were developed by free-trading merchants in medieval Europe long before they were taken over and codified as laws (and often corrupted) by monarchs and governments.

Sometimes, they say we need it to protect the weak, the victims of technological change or trade flows. But throughout history such intervention, though well meant, has usually proved misguided — because its progenitors refuse to believe in (or find out about) David Ricardo's Law of Comparative Advantage: even if China is better at making everything than France, there will still be a million things it pays China to buy from France rather than make itself. Why? Because rather than invent, say, luxury goods or insurance services itself, China will find it pays to make more T shirts and use the proceeds to import luxury goods and insurance.

Government is a very dangerous toy. It is used to fight wars, impose ideologies and enrich rulers. True, nowadays, our leaders do not enrich themselves (at least not on the scale of the Sun King), but they enrich their clients: they preside over vast and insatiable parasitic bureaucracies that grow by Parkinson's Law and live off true wealth creators such as traders and inventors.

Sure, it is possible to have too little government. Only, that has not been the world's problem for millennia. After the century of Mao, Hitler and Stalin, can anybody really say that the risk of too little government is greater than the risk of too much? The dangerous idea we all need

to learn is that the more we limit the growth of government, the better off we will all be.

DAVID PIZARRO
Psychologist, Cornell University

Hodgepodge Morality

What some individuals consider a sacrosanct ability to perceive moral truths may instead be a hodgepodge of simpler psychological mechanisms, some of which have evolved for other purposes.

It is increasingly apparent that our moral sense comprises a fairly loose collection of intuitions, rules of thumb, and emotional responses that may have emerged to serve a variety of functions, some of which originally had nothing at all to do with ethics. These mechanisms, when tossed in with our general ability to reason, seem to be how humans come to answer the question of good and evil, right and wrong. Intuitions about action, intentionality, and control, for instance, figure heavily into our perception of what constitutes an immoral act. The emotional reactions of empathy and disgust likewise figure into our judgments of who deserves moral protection and who doesn't. But the ability to perceive intentions probably didn't evolve as a way to determine who deserves moral blame. And the emotion of disgust most likely evolved to keep us safe from rotten meat and feces, not to provide information about who deserves moral protection.

Discarding the belief that our moral sense provides a royal road to moral truth is an uncomfortable notion. Most people, after all, are moral realists. They believe acts are objectively right or wrong, like math problems. The dangerous idea is that our intuitions may be poor guides to moral truth, and can easily lead us astray in our everyday moral decisions.

RANDOPLH M. NESSE
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Unspeakable Ideas

The idea of promoting dangerous ideas seems dangerous to me. I spend considerable effort to prevent my ideas from becoming dangerous, except, that is, to entrenched false beliefs and to myself. For instance, my idea that bad feelings are useful for our genes upends much conventional wisdom about depression and anxiety. I find, however, that I must firmly restrain journalists who are eager to share the sensational but incorrect conclusion that depression should not be treated. Similarly, many people draw dangerous inferences from my work on Darwinian medicine. For example, just because fever is useful does not mean that it should not be treated. I now emphasize that evolutionary theory does not tell you what to do in the clinic, it just tells you what studies need to be done.

I also feel obligated to prevent my ideas from becoming dangerous on a larger scale. For instance, many people who hear about Darwinian medicine assume incorrectly that it implies support for eugenics. I encourage them to read history as well as my writings. The record shows how quickly natural selection was perverted into Social Darwinism, an ideology that seemed to justify letting poor people starve. Related ideas keep emerging. We scientists have a responsibility to challenge dangerous social policies incorrectly derived from evolutionary theory. Racial superiority is yet another dangerous idea that hurts real people. More examples come to mind all too easily and some quickly get complicated. For instance, the idea that men are inherently different from women has been used to justify discrimination, but the idea that men and women have identical abilities and preferences may also cause great harm.

While I don't want to promote ideas dangerous to others, I am fascinated by ideas that are dangerous to anyone who expresses them. These are "unspeakable ideas." By unspeakable ideas I don't mean those whose expression is forbidden in a certain group. Instead, I propose that there is class of ideas whose expression is inherently dangerous everywhere and always because of the nature of human social groups. Such unspeakable ideas are anti-memes. Memes, both true and false, spread fast because they are interesting and give social credit to those who spread them. Unspeakable ideas, even true important ones, don't spread at all, because expressing them is dangerous to those who speak them.

So why, you may ask, is a sensible scientist even bringing the idea up? Isn't the idea of unspeakable ideas a dangerous idea? I expect I will find out. My hope is that a thoughtful exploration of unspeakable ideas should not hurt people in general, perhaps won't hurt me much, and might unearth some long-neglected truths.

Generalizations cannot substitute for examples, even if providing examples is risky. So, please gather your own data. Here is an experiment. The next time you are having a drink with an enthusiastic fan for your hometown team, say "Well, I think our team just isn't very good and didn't deserve to win." Or, moving to more risky territory, when your business group is trying to deal with a savvy competitor, say, "It seems to me that their product is superior because they are smarter than we are." Finally, and I cannot recommend this but it offers dramatic data, you could respond to your spouse's difficulties at work by saying, "If they are complaining about you not doing enough, it is probably because you just aren't doing your fair share." Most people do not need to conduct such social experiments to know what happens when such unspeakable ideas are spoken.

Many broader truths are equally unspeakable. Consider, for instance, all the articles written

about leadership. Most are infused with admiration and respect for a leader's greatness. Much rarer are articles about the tendency for leadership positions to be attained by power-hungry men who use their influence to further advance their self-interest. Then there are all the writings about sex and marriage. Most of them suggest that there is some solution that allows full satisfaction for both partners while maintaining secure relationships. Questioning such notions is dangerous, unless you are a comic, in which case skepticism can be very, very funny.

As a final example, consider the unspeakable idea of unbridled self-interest. Someone who says, "I will only do what benefits me," has committed social suicide. Tendencies to say such things have been selected against, while those who advocate goodness, honesty and service to others get wide recognition. This creates an illusion of a moral society that then, thanks to the combined forces of natural and social selection, becomes a reality that makes social life vastly more agreeable.

There are many more examples, but I must stop here. To say more would either get me in trouble or falsify my argument. Will I ever publish my "Unspeakable Essays?" It would be risky, wouldn't it?

GREGORY BENFORD
Physicist, UC Irvine; Author, Deep Time

Think outside the Kyoto box

Few economists expect the Kyoto Accords to attain their goals. With compliance coming only slowly and with three big holdouts — the US, China and India — it seems unlikely to make much difference in overall carbon dioxide increases. Yet all the political pressure is on lessening our fossil fuel burning, in the face of fast-rising demand.

This pits the industrial powers against the legitimate economic aspirations of the developing world — a recipe for conflict.

Those who embrace the reality of global climate change mostly insist that there is only one way out of the greenhouse effect — burn less fossil fuel, or else. Never mind the economic consequences. But the planet itself modulates its atmosphere through several tricks, and we have little considered using most of them. The overall global problem is simple: we capture more heat from the sun than we radiate away. Mostly this is a good thing, else the mean planetary temperature would hover around freezing. But recent human alterations of the atmosphere have resulted in too much of a good thing.

Two methods are getting little attention: sequestering carbon from the air and reflecting

sunlight.

Hide the Carbon

There are several schemes to capture carbon dioxide from the air: promote tree growth; trap carbon dioxide from power plants in exhausted gas domes; or let carbon-rich organic waste fall into the deep oceans. Increasing forestation is a good, though rather limited, step. Capturing carbon dioxide from power plants costs about 30% of the plant output, so it's an economic nonstarter.

That leaves the third way. Imagine you are standing in a ripe Kansas cornfield, staring up into a blue summer sky. A transparent acre-area square around you extends upwards in an air-filled tunnel, soaring all the way to space. That long tunnel holds carbon in the form of invisible gas, carbon dioxide — widely implicated in global climate change. But how much?

Very little, compared with how much we worry about it. The corn standing as high as an elephant's eye all around you holds four hundred times as much carbon as there is in man-made carbon dioxide — our villain — in the entire column reaching to the top of the atmosphere. (We have added a few hundred parts per million to our air by burning.) Inevitably, we must understand and control the atmosphere, as part of a grand imperative of directing the entire global ecology. Yearly, we manage through agriculture far more carbon than is causing our greenhouse dilemma.

Take advantage of that. The leftover corn cobs and stalks from our fields can be gathered up, floated down the Mississippi, and dropped into the ocean, sequestering it. Below about a kilometer depth, beneath a layer called the thermocline, nothing gets mixed back into the air for a thousand years or more. It's not a forever solution, but it would buy us and our descendents time to find such answers. And it is inexpensive; cost matters.

The US has large crop residues. It has also ignored the Kyoto Accord, saying it would cost too much. It would, if we relied purely on traditional methods, policing energy use and carbon dioxide emissions. Clinton-era estimates of such costs were around $100 billion a year — a politically unacceptable sum, which led Congress to reject the very notion by a unanimous vote.

But if the US simply used its farm waste to "hide" carbon dioxide from our air, complying with Kyoto's standard would cost about $10 billion a year, with no change whatsoever in energy use.
The whole planet could do the same. Sequestering crop leftovers could offset about a third of the carbon we put into our air.

The carbon dioxide we add to our air will end up in the oceans, anyway, from natural absorption, but not nearly quickly enough to help us.

Reflect Away Sunlight

Hiding carbon from air is only one example of ways the planet has maintained its perhaps

precarious equilibrium throughout billions of years. Another is our world's ability to edit sunlight, by changing cloud cover.

As the oceans warm, water evaporates, forming clouds. These reflect sunlight, reducing the heat below — but just how much depends on cloud thickness, water droplet size, particulate density — a forest of detail.

If our climate starts to vary too much, we could consider deliberately adjusting cloud cover in selected areas, to offset unwanted heating. It is not actually hard to make clouds; volcanoes and fossil fuel burning do it all the time by adding microscopic particles to the air. Cloud cover is a natural mechanism we can augment, and another area where possibility of major change in environmental thinking beckons.

A 1997 US Department of Energy study for Los Angeles showed that planting trees and making blacktop and rooftops lighter colored could significantly cool the city in summer. With minimal costs that get repaid within five years we can reduce summer midday temperatures by several degrees. This would cut air conditioning costs for the residents, simultaneously lowering energy consumption, and lessening the urban heat island effect. Incoming rain clouds would not rise as much above the heat blossom of the city, and so would rain on it less. Instead, clouds would continue inland to drop rain on the rest of Southern California, promoting plant growth. These methods are now under way in Los Angeles, a first experiment.

We can combine this with a cloud-forming strategy. Producing clouds over the tropical oceans is the most effective way to cool the planet on a global scale, since the dark oceans absorb the bulk of the sun's heat. This we should explore now, in case sudden climate changes force us to act quickly.
Yet some environmentalists find all such steps suspect. They smack of engineering, rather than self-discipline. True enough — and that's what makes such thinking dangerous, for some.

Yet if Kyoto fails to gather momentum, as seems probable to many, what else can we do? Turn ourselves into ineffectual Mommy-cop states, with endless finger-pointing politics, trying to equally regulate both the rich in their SUVs and Chinese peasants who burn coal for warmth? Our present conventional wisdom might be termed The Puritan Solution — Abstain, sinners! — and is making slow, small progress. The Kyoto Accord calls for the industrial nations to reduce their carbon dioxide emissions to 7% below the 1990 level, and globally we are farther from this goal every year.

These steps are early measures to help us assume our eventual 21st Century role, as true stewards of the Earth, working alongside Nature. Recently Billy Graham declared that since the Bible made us stewards of the Earth, we have a holy duty to avert climate change. True stewards use the Garden's own methods.

MARCO IACOBONI
Neuroscientist; Director, Transcranial Magnetic Stimulation Lab, UCLA

Media Violence Induces Imitative Violence: The Problem With Super Mirrors

Media violence induces imitative violence. If true, this idea is dangerous for at least two main reasons. First, because its implications are highly relevant to the issue of freedom of speech. Second, because it suggests that our rational autonomy is much more limited than we like to think. This idea is especially dangerous now, because we have discovered a plausible neural mechanism that can explain why observing violence induces imitative violence. Moreover, the properties of this neural mechanism — the human mirror neuron system — suggest that imitative violence may not always be a consciously mediated process. The argument for protecting even harmful speech (intended in a broad sense, including movies and videogames) has typically been that the effects of speech are always under the mental intermediation of the listener/ viewer. If there is a plausible neurobiological mechanism that suggests that such intermediate step can be by-passed, this argument is no longer valid.

For more than 50 years behavioral data have suggested that media violence induces violent behavior in the observers. Meta-data show that the effect size of media violence is much larger than the effect size of calcium intake on bone mass, or of asbestos exposure to cancer. Still, the behavioral data have been criticized. How is that possible? Two main types of data have been invoked. Controlled laboratory experiments and correlational studies assessing types of media consumed and violent behavior. The lab data have been criticized on the account of not having enough ecological validity, whereas the correlational data have been criticized on the account that they have no explanatory power. Here, as a neuroscientist who is studying the human mirror neuron system and its relations to imitation, I want to focus on a recent neuroscience discovery that may explain why the strong imitative tendencies that humans have may lead them to imitative violence when exposed to media violence.

Mirror neurons are cells located in the premotor cortex, the part of the brain relevant to the planning, selection and execution of actions. In the ventral sector of the premotor cortex there are cells that fire in relation to specific goal-related motor acts, such as grasping, holding, tearing, and bringing to the mouth. Surprisingly, a subset of these cells — what we call mirror neurons — also fire when we observe somebody else performing the same action. The behavior of these cells seems to suggest that the observer is looking at her/ his own actions reflected by a mirror, while watching somebody else's actions. My group has also shown in several studies that human mirror neuron areas are critical to imitation. There is also evidence that the activation of this neural system is fairly automatic, thus suggesting that it may by-pass conscious mediation. Moreover, mirror neurons also code the intention associated with observed actions, even though there is not a one-to-one mapping between actions and intentions (I can grasp a cup because I want to drink or because I want to put it in the dishwasher). This suggests that this system can indeed code sequences of action (i.e., what happens after I grasp the cup), even though only one action in the sequence has been

observed.

Some years ago, when we still were a very small group of neuroscientists studying mirror neurons and we were just starting investigating the role of mirror neurons in intention understanding, we discussed the possibility of super mirror neurons. After all, if you have such a powerful neural system in your brain, you also want to have some control or modulatory neural mechanisms. We have now preliminary evidence suggesting that some prefrontal areas have super mirrors. I think super mirrors come in at least two flavors. One is inhibition of overt mirroring, and the other one — the one that might explain why we imitate violent behavior, which require a fairly complex sequence of motor acts — is mirroring of sequences of motor actions. Super mirror mechanisms may provide a fairly detailed explanation of imitative violence after being exposed to media violence.

BARRY C. SMITH
Philosopher, Birbeck, University of London; Coeditor, Knowing Our Own Minds

What We Know May Not Change Us

Human beings, like everything else, are part of the natural world. The natural world is all there is. But to say that everything that exists is just part of the one world of nature is not the same as saying that there is just one theory of nature that will describes and explain everything that there is. Reality may be composed of just one kind of stuff and properties of that stuff but we need many different kinds of theories at different levels of description to account for everything there is.

Theories at these different levels may not be reduced one to another. What matters is that they be compatible with one another. The astronomy Newton gave us was a triumph over supernaturalism because it united the mechanics of the sub-lunary world with an account of the heavenly bodies. In a similar way, biology allowed us to advance from a time when we saw life in terms of an elan vital. Today, the biggest challenge is to explain our powers of thinking and imagination, our abilities to represent and report our thoughts: the very means by which we engage in scientific theorising. The final triumph of the natural sciences over supernaturalism will be an account of nature of conscious experience. The cognitive and brain sciences have done much to make that project clearer but we are still a long way from a fully satisfying theory.

But even if we succeed in producing a theory of human thought and reason, of perception, of conscious mental life, compatible with other theories of the natural and biological world, will we relinquish our cherished commonsense conceptions of ourselves as human beings, as selves who know ourselves best, who deliberate and decide freely on what to do and how to

live? There is much evidence that we won't. As humans we conceive ourselves as centres of experience, self-knowing and free willing agents. We see ourselves and others as acting on our beliefs, desires, hopes and fears, and has having responsibility for much that we do and all that we say. And even as results in neuroscience begin to show how much more automated, routinised and pre-conscious much of our behaviour is, we are remain unable to let go of the self-beliefs that govern our day to day rationalisings and dealings with others.

We are perhaps incapable of treating others as mere machines, even if that turns out to be what we are. The self-conceptions we have are firmly in place and sustained in spite of our best findings, and it may be a fact about human beings that it will always be so. We are curious and interested in neuroscientists findings and we wonder at them and about their applications to ourselves, but as the great naturalistic philosopher David Hume knew, nature is too strong in us, and it will not let us give up our cherished and familiar ways of thinking for long. Hume knew that however curious an idea and vision of ourselves we entertained in our study, or in the lab, when we returned to the world to dine, make merry with our friends our most natural beliefs and habits returned and banished our stranger thoughts and doubts. It is likely, as this end of the year, that whatever we have learned and whatever we know about the error of our thinkings and about the fictions we maintain, they will still remain the most dominant guiding force in our everyday lives. We may not be comforted by this, but as creatures with minds who know they have minds — perhaps the only minded creatures in nature in this position — we are at least able to understand our own predicament.

PHILIP W. ANDERSON
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Dark Energy might not exist

Let's try one in cosmology. The universe contains at least 3 and perhaps 4 very different kinds of matter, whose origins probably are physically completely different. There is the Cosmic Background Radiation (CBR) which is photons from the later parts of the Big Bang but is actually the residue of all the kinds of radiation that were in the Bang, like flavored hadrons and mesons which have annihilated and become photons. You can count them and they tell you pretty well how many quanta of radiation there were in the beginning; and observation tells us that they were pretty uniformly distributed, in fact very, and still are.

Next is radiant matter — protons, mostly, and electrons. There are only a billionth as many of them as quanta of CBR, but as radiation in the Big Bang there were pretty much the same number, so all but one out of a billion combined with an antiparticle and annihilated. Nonetheless they are much heavier than the quanta of CBR, so they have, all told, much more

mass, and have some cosmological effect on slowing down the Hubble expansion. There was an imbalance — but what caused that? That imbalance was generated by some totally independent process, possibly during the very turbulent inflationary era.

In fact out to a tenth of the Hubble radius, which is as far as we can see, the protons are very *non*-uniformly distributed, in a fractal hierarchical clustering with things called "Great Walls" and giant near-voids. The conventional idea is that this is all caused by gravitational instability acting on tiny primeval fluctuations, and it barely could be, but in order to justify that you have to have another kind of matter.

So you need — and actually see, but indirectly — Dark Matter, which is 30 times as massive, overall, as protons but you can't see anything but its gravitational effects. No one has much clue as to what it is but it seems to have to be assumed it is hadronic, otherwise why would it be anything as close as a factor 30 to the protons? But really, there is no reason at all to suppose its origin was related to the other two, you know only that if it's massive quanta of any kind it is nowhere near as many as the CBR, and so most of them annihilated in the early stages. Again, we have no excuse for assuming that the imbalance in the Dark Matter was uniformly distributed primevally, even if the protons were, because we don't know what it is.

Finally, of course there is Dark Energy, that is if there is. On that we can't even guess if it is quanta at all, but again we note that if it is it probably doesn't add up in numbers to the CBR. The very strange coincidence is that when we add this in there isn't any total gravitation at all, and the universe as a whole is flat, as it would be, incidentally, if all of the heavy parts were distributed everywhere according to some random, fractal distribution like that of the matter we can see — because on the largest scale, a fractal's density extrapolates to zero. That suggestion, implying that Dark Energy might not exist, is considered very dangerously radical.

The posterior probability of any particular God is pretty small

Here's another, which compared to many other peoples' propositions isn't so radical. Isn't God very improbable? You can't in any logical system I can understand *disprove* the existence of God, or prove it for that matter. But I think that in the probability calculus I use He is very improbable.

There are a number of ways of making a formal probability theory which incorporate Ockham's razor, the principle that one must not multiply hypotheses unnecessarily. Two are called Bayesian probability theory, and Minimum Entropy. If you have been taking data on something, and the data are reasonably close to a straight line, these methods give us a definable procedure by which you can estimate the probability that the straight line is correct, not the polynomial which has as many parameters as there are points, or some intermediate complex curve. Ockham's razor is expressed mathematically as the fact that there is a factor in the probability derived for a given hypothesis that decreases exponentially in the number N of parameters that describe your hypothesis — it is the inverse of the volume of parameter space. People who are trying to prove the existence of ESP abominate Bayesianism and this factor because it strongly favors the "Null hypothesis" and beats them every time.

Well, now, imagine how big the parameter space is for God. He could have a long gray beard

or not, be benevolent or malicious in a lot of different ways and over a wide range of values, he can have a variety of views on abortion, contraception, like or abominate human images, like or abominate music, and the range of dietary prejudices He has been credited with is as long as your arm. There is the heaven-hell dimension, the one vs three question, and I haven't even mentioned polytheism. I think there are certainly as many parameters as sects, or more. If there is even a sliver of prior probability for the null hypothesis, the posterior probability of any particular God is pretty small.

TIMOTHY TAYLOR
Archaeologist, University of Bradford; Author, The Buried Soul

The human brain is a cultural artefact.

Phylogenetically, humans represent an evolutionary puzzle. Walking on two legs free the hands to do new things, like chip stones to make modified tools — the first artefacts, dating to 2.7 million years ago — but it also narrows the pelvis and dramatically limits the size of possible fetal cranium. Thus the brain expansion that began after 2 million years ago should not have happened.

But imagine that, alongside chipped stone tools, one genus of hominin appropriates the looped entrails of a dead animal, or learns to tie a simple knot, and invents a sling (chimpanzees are known to carry water in leaves and gorillas to measure water depth with sticks, so the practical and abstract thinking required here can be safely assumed for our human ancestors by this point).

In its sling, the hominin child can now hip ride with little impairment to its parent's hands-free movement. This has the unexpected and certainly unplanned consequence that it is no longer important for it to be able to hang on as chimps do. Although, due to the bio-mechanical constraints of a bipedal pelvis, the hominin child cannot be *born* with a big head (thus large initial brain capacity) it can now be born underdeveloped. That is to say, the sling frees fetuses to be born in an ever more ontogenically retarded state. This trend, which humans do indeed display, is called neoteny. The retention of earlier features for longer means that the total developmental sequence is extended in time far beyond the nine months of natural gestation. Hominin children, born underdeveloped, could grow their crania outside the womb in the pseudo-marsupial pouch of an infant-carrying sling.

From this point onwards it is not hard to see how a distinctively human culture emerges through the extra-uterine formation of higher cognitive capacities — the phylogenetic and ontogenic icing on the cake of primate brain function. The child, carried by the parent into social situations, watches vocalization. Parental selection for smart features such as an ability

to babble early may well, as others have suggested, have driven the brain size increases until 250,000 years ago — a point when the final bio-mechanical limits of big-headed mammals with narrow pelvises were reached by two species: Neanderthals and us.

This is the phylogeny side of the case. In terms of ontogeny the obvious applies — it recapitulates phylogeny. The underdeveloped brains of hominin infants were culture-prone, and in this sense, I do not dissent from Dan Sperber's dangerous idea that ‘culture is natural'. But human culture, unlike the basic culture of learned routines and tool-using observed in various mammals, is a system of signs — essentially the association of words with things and the ascription and recognition of value in relation to this.

As Ernest Gellner once pointed out, taken cross-culturally, as a species, humans exhibit by far the greatest range of behavioural variation of any animal. However, within any on-going community of people, with language, ideology and a culturally-inherited and developed technology, conformity has usually been a paramount value, with death often the price for dissent. My belief is that, due to the malleability of the neotenic brain, cultural systems are physically built into the developing tissue of the mind.

Instead of seeing the brain as the genetic hardware into which the cultural software is loaded, and then arguing about the relative determining influences of each in areas such as, say, sexual orientation or mathematical ability (the old nature-nurture debate), we can conclude that culture (as Richard Dawkins long ago noted in respect of contraception) acts to subvert genes, but is also enabled by them. Ontogenic retardation allowed both environment and the developing milieu of cultural routines to act on brain hardware construction alongside the working through of the genetic blueprint. Just because the modern human brain is coded for by genes does not mean that the critical self-consciousness for which it (within its own community of brains) is famous is non-cultural any more than a barbed-and-tanged arrowhead is non-cultural just because it is made of flint.

The human brain has a capacity to go not just beyond nature, but beyond culture too, by dissenting from old norms and establishing others. The emergence of the high arts and science is part of this process of the human brain, with its instrumental extra-somatic adaptations and memory stores (books, laboratories, computers), and is underpinned by the most critical thing that has been brought into being in the encultured human brain: free will.

However, not all humans, or all human communities, seem capable of equal levels of free-will. In extreme cases they appear to display none at all. Reasons include genetic incapacity, but it is also possible for a lack of mental freedom to be culturally engendered, and sometimes even encouraged. Archaeologically, the evidence is there from the first farming societies in Europe: the Neolithic massacre at Talheim, where an entire community was genocidally wiped out except for the youngest children, has been taken as evidence (supported by anthropological analogies) of the re-enculturation of still flexible minds within the community of the victors, to serve and live out their orphaned lives as slaves. In the future, one might surmise that the dark side of the development of virtual reality machines (described by Clifford Pickover) will be the infinitely more subtle cultural programming of impressionable individuals as sophisticated conformists.

The interplay of genes and culture has produced in us potential for a formidable range of abilities and intelligences. It is critical that in the future we both fulfil and extend this potential in the realm of judgment, choice and understanding in both sciences and arts. But the idea of the brain as a cultural artefact is dangerous. Those with an interest in social engineering — tyrants and authoritarian regimes — will almost certainly attempt to develop it to their advantage. Free-will is threatening to the powerful who, by understanding its formation, will act to undermine it in sophisticated ways. The usefulness of cultural artefacts that have the degree of complexity of human brains makes our own species the most obvious candidate for the enhanced super-robot of the future, not just smart factory operatives and docile consumers, but cunning weapons-delivery systems (suicide bombers) and conformity-enforcers. At worst, the very special qualities of human life that have been enabled by our remarkable natural history, the confluence of genes and culture, could end up as a realm of freedom for an elite few.

OLIVER MORTON

Chief News and Features Editor at Nature; Author, Mapping Mars

Our planet is not in peril

The truth of this idea is pretty obvious. Environmental crises are a fundamental part of the history of the earth: there have been sudden and dramatic temperature excursions, severe glaciations, vast asteroid and comet impacts. Yet the earth is still here, unscathed.

There have been mass extinctions associated with some of these events, while other mass extinctions may well have been triggered by subtler internal changes to the biosphere. But none of them seem to have done long-term harm. The first ten million years of the Triassic may have been a little dull by comparison to the late Palaeozoic, what with a large number of the more interesting species being killed in the great mass extinction at the end of the Permian, but there is no evidence that any fundamentally important earth processes did not eventually recover. I strongly suspect that not a single basic biogeochemical innovation — the sorts of thing that underlie photosynthesis and the carbon cycle, the nitrogen cycle, the sulphur cycle and so on — has been lost in the past 4 billion years.

Indeed, there is an argument to be made that mass extinctions are in fact a good thing, in that they wipe the slate clean a bit and thus allow exciting evolutionary innovations. This may be going a bit far. While the Schumpeter-for-the-earth-system position seems plausible, it also seems a little crudely progressivist. While to a mammal the Tertiary seems fairly obviously superior to the Cretaceous, it's not completely clear to me that there's an objective basis for that belief. In terms of primary productivity, for example, the Cretaceous may well have had an edge. But despite all this, it's hard to imagine that the world would be a substantially better

place if it had not undergone the mass extinctions of the Phanerozoic.

Against this background, the current carbon/ climate crisis seems pretty small beer. The change in mean global temperatures seems quite unlikely to be much greater than the regular cyclical change between glacial and interglacial climates. Land use change is immense, but it's not clear how long it will last, and there are rich seedbanks in the soil that will allow restoration. If fossil fuel use goes unchecked, carbon dioxide levels may rise as high as they were in the Eocene, and do so at such a rate that they cause a transient spike in ocean acidity. But they will not stay at those high levels, and the Eocene was not such a terrible place.

The earth doesn't need ice caps, or permafrost, or any particular sea level. Such things come and go and rise and fall as a matter of course. The planet's living systems adapt and flourish, sometimes in a way that provides negative feedback, occasionally with a positive feedback that amplifies the change. A planet that made it through the massive biogeochemical unpleasantness of the late Permian is in little danger from a doubling, or even a quintupling, of the very low carbon dioxide level that preceded the industrial revolution, or from the loss of a lot of forests and reefs, or from the demise of half its species, or from the thinning of its ozone layer at high latitudes.

But none of this is to say that we as people should not worry about global change; we should worry a lot. This is because climate change may not hurt the planet, but it hurts people. In particular, it will hurt people who are too poor to adapt. Significant climate change will change rainfall patterns, and probably patterns of extreme events as well, in ways that could easily threaten the food security of hundreds of millions of people supporting themselves through subsistence agriculture or pastoralism. It will have a massive effect on the lives of the relatively small number of people in places where sea ice is an important part of the environment (and it seems unlikely that anything we do now can change that). In other, more densely populated places local environmental and biotic change may have similarly sweeping effects.

Secondary to this, the loss of species, both known and unknown, will be experienced by some as a form of damage that goes beyond any deterioration in ecosystem services. Many people will feel themselves and their world diminished by such extinctions even when they have no practical consequences, despite the fact that they cannot ascribe an objective value to their loss. One does not have to share the values of these people to recognise their sincerity.

All of these effects provide excellent reasons to act. And yet many people in the various green movements feel compelled to add on the notion that the planet itself is in crisis, or doomed; that all life on earth is threatened. And in a world where that rhetoric is common, the idea that this eschatological approach to the environment is baseless is a dangerous one. Since the 1970s the environmental movement has based much of its appeal on personifying the planet and making it seem like a single entity, then seeking to place it in some ways "in our care". It is a very powerful notion, and one which benefits from the hugely influential iconographic backing of the first pictures of the earth from space; it has inspired much of the good that the environmental movement has done. The idea that the planet is not in peril could thus come to undermine the movement's power. This is one of the reasons people react against the idea so strongly. One respected and respectable climate scientist reacted to Andy Revkin's recent use of the phrase "In fact, the planet has nothing to worry about from global warming" in the *New*

York Times with near apoplectic fury.

If the belief that the planet is in peril were merely wrong, there might be an excuse for ignoring it, though basing one's actions on lies is an unattractive proposition. But the planet-in-peril idea is an easy target for those who, for various reasons, argue against any action on the carbon/ climate crisis at all. In this, bad science is a hostage to fortune. What's worse, the idea distorts environmental reasoning, too. For example, laying stress on the non-issue of the health of the planet, rather than the real issues of effects that harm people, leads to a general preference for averting change rather than adapting to it, even though providing the wherewithal for adaptation will often be the most rational response.

The planet-in-peril idea persists in part simply through widespread ignorance of earth history. But some environmentalists, and perhaps some environmental reporters, will argue that the inflated rhetoric that trades on this error is necessary in order to keep the show on the road. The idea that people can be more easily persuaded to save the planet, which is not in danger, than their fellow human beings, who are, is an unpleasant and cynical one; another dangerous idea, not least because it may indeed hold some truth. But if putting the planet at the centre of the debate is a way of involving everyone, of making us feel that we're all in this together, then one can't help noticing that the ploy isn't working out all that well. In the rich nations, many people may indeed believe that the planet is in danger — but they don't believe that they are in danger, and perhaps as a result they're not clamouring for change loud enough, or in the right way, to bring it about.

There is also a problem of learned helplessness. I suspect people are flattered, in a rather perverse way, by the idea that their lifestyle threatens the whole planet, rather than just the livelihoods of millions of people they have never met. But the same sense of scale that flatters may also enfeeble. They may come to think that the problems are too great for them to do anything about.

Rolling carbon/ climate issues into the great moral imperative of improving the lives of the poor, rather than relegating them to the dodgy rhetorical level of a threat to the planet as a whole, seems more likely to be a sustainable long-term strategy. The most important thing about environmental change is that it hurts people; the basis of our response should be human solidarity.

The planet will take care of itself.

SAMUEL BARONDES
Neurobiologist and Psychiatrist, University of California San Francisco; Author, Better Than Prozac

Using Medications To Change Personality

Personality — the pattern of thoughts, feelings, and actions that is typical of each of us — is generally formed by early adulthood. But many people still want to change. Some, for example, consider themselves too gloomy and uptight and want to become more cheerful and flexible. Whatever their aims they often turn to therapists, self-help books, and religious practices.

In the past few decades certain psychiatric medications have become an additional tool for those seeking control of their lives. Initially designed to be used for a few months to treat episodic psychological disturbances such as severe depression, they are now being widely prescribed for indefinite use to produce sustained shifts in certain personality traits. Prozac is the best known of them, but many others are on the market or in development. By directly affecting brain circuits that control emotions, these medications can produce desirable effects that may be hard to replicate by sheer force of will or by behavioral exercises. Millions keep taking them continuously, year after year, to modulate personality.

Nevertheless, despite the testimonials and apparent successes, the sustained use of such drugs to change personality should still be considered dangerous. Not because manipulation of brain chemicals is intrinsically cowardly, immoral, or a threat to the social order. In the opinion of experienced clinicians medications such as Prozac may actually have the opposite effect, helping to build character and to increase personal responsibility. The real danger is that there are no controlled studies of the effects of these drugs on personality over the many years or even decades in which some people are taking them. So we are left with a reliance on opinion and belief. And this, as in all fields, we know to be dangerous.

DAVID BODANIS
Writer, Consultant; Author: The Electric Universe

The hyper-Islamicist critique of the West as a decadent force that is already on a downhill course might be true

I wonder sometimes if the hyper-Islamicist critique of the West as a decadent force that is already on a downhill course might be true. At first it seems impossible: no one's richer than the US, and no one has as powerful an Army; western Europe has vast wealth and university skills as well.

But what got me reflecting was the fact that in just four years after Pearl Harbor, the US had defeated two of the greatest military forces the world had ever seen. Everyone naturally accepted there had to be restrictions on gasoline sales, to preserve limited source of gasoline

and rubber; profiteers were hated. But the first four years after 9/ 11? Detroit automakers find it easy to continue paying off congressmen to ensure that gasoline-wasting SUV's aren't restricted in any way.

There are deep trends behind this. Technology is supposed to be speeding up, but if you think about it, airplanes have a similar feel and speed to ones of 30 years ago; cars and oil rigs and credit cards and the operations of the NYSE might be a bit more efficient than a few decades ago, but also don't feel fundamentally different. Aside from the telephones, almost all the objects and and daily habits in Spielberg's 20 year old film E.T. are about the same as today.

What has transformed is the possibility of quick change. It's a lot, lot harder than it was before. Patents for vague, general ideas are much easier to get than they were before, which slows down the introduction of new technology; academics in biotech and other fields are wary about sharing their latest research with potentially competing colleagues (which slows down the creation of new technology as well).

Even more, there's a tension, a fear of falling from the increasingly fragile higher tiers of society, which means that social barriers are higher as well. I went to adequate but not extraordinary public (state) schools in Chicago, but my children go to private schools. I suspect that many contributors to this site, unless they live in academic towns where state schools are especially strong, are in a similar position. This is fine for our children, but not for those of the same theoretical potential, yet who lack parents who can afford it.

Sheer inertia can mask such flaws for quite a while. The National Academy of Sciences has shown that, once again, the percentage of American-born university students studying the hard physical sciences has gone down. At one time that didn't matter, for life in America — and at the top American universities — was an overwhelming lure for ambitious youngsters from Seoul and Bangalore. But already there are signs of that slipping, and who knows what it'll be like in another decade or two.

There's another sort of inertia that's coming to an end as well. The first generation of immigrants from farm to city bring with them the attitudes of their farm world; the first generation of 'migrants' from blue collar city neighborhoods to upper middle class professional life bring similar attitudes of responsibility as well. We ignore what the media pours out about how we're supposed to live. We're responsible for parents, even when it's not to our economic advantage; we vote against our short-term economic interests, because it's the 'right' thing to do; we engage in philanthropy towards individuals of very different backgrounds from ourselves. But why? In many parts of America or Europe, the rules and habits creating those attitudes no longer exist at all.

When that finally gets cut away, will what replaces it be strong enough for us to survive?

NICHOLAS HUMPHREY
Psychologist, London School of Economics; Author, The Mind Made Flesh

It is undesirable to believe in a proposition when there is no ground whatever for supposing it true

Bertrand Russell's idea, put forward 80 years ago, is about as dangerous as they come. I don't think I can better it: "I wish to propose for the reader's favourable consideration a doctrine which may, I fear, appear wildly paradoxical and subversive. The doctrine in question is this: that it is undesirable to believe in a proposition when there is no ground whatever for supposing it true." (The opening lines of his *Sceptical essays*).

ERIC FISCHL
Artist, New York City; Mary Boone Gallery

The unknown becomes known, and is not replaced with a new unkown

Several years ago I stood in front of a painting by Vermeer. It was a painting of a woman reading a letter. She stood near the window for better lighting and behind her hung a map of the known world. I was stunned by the revelation of this work. Vermeer understood something so basic to human need it had gone virtually unnoticed: communication from afar.

Everything we have done to make us more capable, more powerful, better protected, more intelligent, has been by enhancing our physical limitations, our perceptual abilities, our adaptability. When I think of Vermeer's woman reading the letter I wonder how long did it take to get to her? Then I think, my god, at some time we developed a system in which one could leave home and send word back! We figured out a way that we could be heard from far away and then another system so that we can be seen from far away. Then I start to marvel at the alchemy of painting and how we have been able to invest materials with consciousness so that Vermeer can talk to me across time! I see too he has put me in the position of not knowing as I am kept from reading the content of the letter. In this way he has placed me at the edge, the frontier of wanting to know what I cannot know. I want to know how long has this letter sender been away and what was he doing all this time. Is he safe? Does he still love her? Is he on his way home?

Vermeer puts me into what had been her condition of uncertainty. All I can do is wonder and wait. This makes me think about how not knowing is so important. Not knowing makes the

world large and uncertain and our survival tenuous. It is a mystery why humans roam and still more a mystery why we still need to feel so connected to the place we have left. The not knowing causes such profound anxiety it, in turn, spawns creativity. The impetus for this creativity is empowerment. Our gadgets, gizmoes, networks of transportation and communication, have all been developed either to explore, utilize or master the unknown territory.

If the unknown becomes known, and is not replaced with a new unknown, if the farther we reach outward is connected only to how fast we can bring it home, if the time between not knowing and knowing becomes too small, creativity will be daunted. And so I worry, if we bring the universe more completely, more effortlessly, into our homes will there be less reason to leave them?

STANISLAS DEHEANE
Cognitive Neuropsychology Researcher, Institut National de la Santé, Paris; Author, The Number Sense

Touching and pushing the limits of the human brain

From Copernicus to Darwin to Freud, science has a special way of deflating human *hubris* by proposing what is frequently perceived, at the time, as dangerous or pernicious ideas. Today, cognitive neuroscience presents us with a new challenging idea, whose accommodation will require substantial personal and societal effort — the discovery of the intrinsic limits of the human brain.

Calculation was one of the first domains where we lost our special status — right from their inception, computers were faster than the human brain, and they are now billions of times ahead of us in their speed and breadth of number crunching. Psychological research shows that our mental "central executive" is amazingly limited — we can process only one thought at a time, at a meager rate of five or ten per second at most. This is rather surprising. Isn't the human brain supposed to be the most massively parallel machine on earth? Yes, but its architecture is such that the collective outcome of this parallel organization, our mind, is a very slow serial processor. What we can become aware of is intrinsically limited. Whenever we delve deeply into the processing of one object, we become literally blind to other items that would require our attention (the "attentional blink" paradigm). We also suffer from an "illusion of seeing": we think that we take in a whole visual scene and see it all at once, but research shows that major chunks of the image can be changed surreptitiously without our noticing.

True, relative to other animal species, we do have a special combinatorial power, which lies at the heart of the remarkable cultural inventions of mathematics, language, or writing. Yet this

combinatorial faculty only works on the raw materials provided by a small number of core systems for number, space, time, emotion, conspecifics, and a few other basic domains. The list is not very long — and within each domain, we are now discovering lots of little ill-adapted quirks, evidence of stupid design as expected from a brain arising from an imperfect evolutionary process (for instance, our number system only gives us a sense of approximate quantity — good enough for foraging, but not for exact mathematics). I therefore do not share Marc Hauser's optimism that our mind has a "universal" or "limitless" expressive power. The limits are easy to touch in mathematics, in topology for instance, where we struggle with the simplest objects (is a curve a knot… or not?).

As we discover the limits of the human brain, we also find new ways to design machines that go beyond those limits. Thus, we have to get ready for a society where, more and more, the human mind will be replaced by better computers and robots — and where the human operator will be increasingly considered a nuisance rather than an asset. This is already the case in aeronautics, where flight stability is ensured by fast cybernetics and where landing and take off will soon be assured by computer, apparently with much improved safety.

There are still a few domains where the human brain maintains an apparent superiority. Visual recognition used to be one — but already, superb face recognition software is appearing, capable of storing and recognizing thousands of faces with close to human performance. Robotics is another. No robot to date is capable of navigating smoothly through a complicated 3-D world. Yet a third area of human superiority is high-level semantics and creativity: the human ability to make sense of a story, to pull out the relevant knowledge from a vast store of potentially useful facts, remains unequalled.

Suppose that, for the next 50 years, those are the main areas in which engineers will remain unable to match the performance of the human brain. Are we ready for a world in which the human contributions are binary, either at the highest level (thinkers, engineers, artists…) or at the lowest level, where human workforce remains cheaper than mechanization? To some extent, I would argue that this great divide is already here, especially between North and South, but also within our developed countries, between upper and lower casts.

What are the solutions? I envisage two of them. The first is education. The human brain to some extent is changeable. Thanks to education, we can improve considerably upon the stock of mental tools provided to us by evolution. In fact, relative to the large changes that schooling can provide, whatever neurobiological differences distinguish the sexes or the races are minuscule (and thus largely irrelevant — *contra* Steve Pinker). The crowning achievements of Sir Isaac Newton are now accessible to any student in physics and algebra — whatever his or her skin color.

Of course, our learning ability isn't without bounds. It is itself tightly limited by our genes, which merely allow a fringe of variability in the laying down of our neuronal networks. We never fully gain entirely new abilities — but merely transform our existing brain networks, a partial and constrained process that I have called "cultural recycling" or "recyclage".

As we gain knowledge of brain plasticity, a major application of cognitive neuroscience research should be the improvement of life-long education, with the goal of optimizing this

transformation of our brains. Consider reading. We now understand much better how this cultural capacity is laid down. A posterior brain network, initially evolved to recognize objects and faces, gets partially recycled for the shapes of letters and words, and learns to connect these shapes to other temporal areas for sounds and words. Cultural evolution has modified the shapes of letters so that they are easily learnable by this brain network. But, the system remains amazingly imperfect. Reading still has to go through the lopsided design of the retina, where the blood vessels are put in front of the photoreceptors, and where only a small region of the fovea has enough resolution to recognize small print. Furthermore, both the design of writing systems and the way in which they are taught are perfectible. In the end, after years of training, we can only read at an appalling speed of perhaps 10 words per second, a baud rate surpassed by any present-day modem.

Nevertheless, this cultural invention has radically changed our cognitive abilities, doubling our verbal working memory for instance. Who knows what other cultural inventions might lie ahead of us, and might allow us to further push the limits of our brain biology?

A second, more futuristic solution may lie in technology. Brain-computer interfaces are already around the corner. They are currently being developed for therapeutic purposes. Soon, cortical implants will allow paralyzed patients to move equipment by direct cerebral command. Will such devices later be applied to the normal human brain, in the hopes of extending our memory span or the speed of our access to information? And will we be able to forge a society in which such tools do not lead to further divisions between, on the one hand, high-tech brains powered by the best education and neuro-gear, and on the other hand, low-tech man power just good enough for cheap jobs?

JOEL GARREAU
Cultural Revolution Correspondent, Washington Post *; Author,* Radical Evolution

Suppose Faulkner was right?

In his December 10, 1950, Nobel Prize acceptance speech, William Faulkner said:

I decline to accept the end of man. It is easy enough to say that man is immortal simply because he will endure: that when the last ding-dong of doom has clanged and faded from the last worthless rock hanging tideless in the last red and dying evening, that even then there will still be one more sound: that of his puny inexhaustible voice, still talking. I refuse to accept this. I believe that man will not merely endure: he will prevail.

He is immortal, not because he alone among creatures has an inexhaustible voice, but because he has a soul, a

spirit capable of compassion and sacrifice and endurance. The poet's, the writer's, duty is to write about these things. It is his privilege to help man endure by lifting his heart, by reminding him of the courasge and honor and hope and pride and compassion and pity and sacrifice which have been the glory of his past. The poet's voice need not merely be the record of man, it can be one of the props, the pillars to help him endure and prevail.

It's easy to dismiss such optimism. The reason I hope Faulkner was right, however, is that we are at a turning point in history. For the first time, our technologies are not so much aimed outward at modifying our environment in the fashion of fire, clothes, agriculture, cities and space travel. Instead, they are increasingly aimed inward at modifying our minds, memories, metabolisms, personalities and progeny. If we can do all that, then we are entering an era of engineered evolution — radical evolution, if you will — in which we take control of what it will mean to be human.

This is not some distant, science-fiction future. This is happening right now, in our generation, on our watch. The GRIN technologies — the genetic, robotic, information and nano processes — are following curves of accelerating technological change the arithmetic of which suggests that the last 20 years are not a guide to the next 20 years. We are more likely to see that magnitude of change in the next eight. Similarly, the amount of change of the last half century, going back to the time when Faulkner spoke, may well be compressed into the next 14.

This raises the question of where we will gain the wisdom to guide this torrent, and points to what happens if Faulkner was wrong. If we humans are not so much able to control our tools, but instead come to be controlled by them, then we will be heading into a technodeterminist future.

You can get different versions of what that might mean.

Some would have you believe that a future in which our creations eliminate the ills that have plagued mankind for millennia — conquering pain, suffering, stupidity, ignorance and even death — is a vision of heaven. Some even welcome the idea that someday soon, our creations will surpass the pitiful limitations of Version 1.0 humans, themselves becoming a successor race that will conquer the universe, and care for us benevolently.

Others feel strongly that a life without suffering is a life without meaning, reducing humankind to ignominious, character-less husks. They also point to what could happen if such powerful self-replicating technologies get into the hands of bumblers or madmen. They can easily imagine a vision of hell in which we wipe out not only our species, but all of life on earth.

If Faulkner is right, however, there is a third possible future. That is the one that counts on the ragged human convoy of divergent perceptions, piqued honor, posturing, insecurity and humor once again wending its way to glory. It puts a shocking premium on Faulkner's hope that man will prevail "because he has a soul, a spirit capable of compassion and sacrifice and endurance." It assumes that even as change picks up speed, giving us less and less time to react, we will still be able to rely on the impulse that Churchill described when he said, "Americans can always be counted on to do the right thing—after they have exhausted all

other possibilities."

The key measure of such a "prevail" scenario's success would be an increasing intensity of links between humans, not transistors. If some sort of transcendence is achieved beyond today's understanding of human nature, it would not be through some individual becoming superman. Transcendence would be social, not solitary. The measure would be the extent to which many transform together.

The very fact that Faulkner's proposition looms so large as we look into the future does at least illuminate the present.

Referring to Faulkner's breathtaking line, "when the last ding-dong of doom has clanged and faded from the last worthless rock hanging tideless in the last red and dying evening, that even then there will still be one more sound: that of his puny inexhaustible voice, still talking," the author Bruce Sterling once told me, "You know, the most interesting part about that speech is that part right there, where William Faulkner, of all people, is alluding to H. G. Wells and the last journey of the Traveler from *The Time Machine*. It's kind of a completely heartfelt, probably drunk mishmash of cornball crypto-religious literary humanism and the stark, bonkers, apocalyptic notions of atomic Armageddon, human extinction, and deep Darwinian geological time. Man, that was the 20th century all over."

HELEN FISHER

Research Professor, Department of Anthropology, Rutgers University; Author, Why We Love

If patterns of human love subtlely change, all sorts of social and political atrocities can escalate

Serotonin-enhancing antidepressants (such as Prozac and many others) can jeopardize feelings of romantic love, feelings of attachment to a spouse or partner, one's fertility and one's genetic future.

I am working with psychiatrist Andy Thomson on this topic. We base our hypothesis on patient reports, fMRI studies, and other data on the brain.

Foremost, as SSRIs elevate serotonin they also suppress dopaminergic pathways in the brain. And because romantic love is associated with elevated activity in dopaminergic pathways, it follows that SSRIs can jeopardize feelings of intense romantic love. SSRIs also curb obsessive thinking and blunt the emotions--central characteristics of romantic love. One patient described this reaction well, writing: "After two bouts of depression in 10 years, my therapist recommended I stay on serotonin-enhancing antidepressants indefinitely. As appreciative as I

was to have regained my health, I found that my usual enthusiasm for life was replaced with blandness. My romantic feelings for my wife declined drastically. With the approval of my therapist, I gradually discontinued my medication. My enthusiasm returned and our romance is now as strong as ever. I am prepared to deal with another bout of depression if need be, but in my case the long-term side effects of antidepressants render them off limits".

SSRIs also suppress sexual desire, sexual arousal and orgasm in as many as 73% of users. These sexual responses evolved to enhance courtship, mating and parenting. Orgasm produces a flood of oxytocin and vasopressin, chemicals associated with feelings of attachment and pairbonding behaviors. Orgasm is also a device by which women assess potential mates. Women do not reach orgasm with every coupling and the "fickle" female orgasm is now regarded as an adaptive mechanism by which women distinguish males who are willing to expend time and energy to satisfy them. The onset of female anorgasmia may jeopardize the stability of a long-term mateship as well.

Men who take serotonin-enhancing antidepressants also inhibit evolved mechanisms for mate selection, partnership formation and marital stability. The penis stimulates to give pleasure and advertise the male's psychological and physical fitness; it also deposits seminal fluid in the vaginal canal, fluid that contains dopamine, oxytocin, vasopressin, testosterone, estrogen and other chemicals that most likely influence a female partner's behavior.

These medications can also influence one's genetic future. Serotonin increases prolactin by stimulating prolactin releasing factors. Prolactin can impair fertility by suppressing hypothalamic GnRH release, suppressing pituitary FSH and LH release, and/ or suppressing ovarian hormone production. Clomipramine, a strong serotonin-enhancing antidepressant, adversely affects sperm volume and motility.

I believe that Homo sapiens has evolved (at least) three primary, distinct yet overlapping neural systems for reproduction. The sex drive evolved to motivate ancestral men and women to seek sexual union with a range of partners; romantic love evolved to enable them to focus their courtship energy on a preferred mate, thereby conserving mating time and energy; attachment evolved to enable them to rear a child through infancy together. The complex and dynamic interactions between these three brain systems suggest that any medication that changes their chemical checks and balances is likely to alter an individual's courting, mating and parenting tactics, ultimately affecting their fertility and genetic future.

The reason this is a dangerous idea is that the huge drug industry is heavily invested in selling these drugs; millions of people currently take these medications worldwide; and as these drugs become generic, many more will soon imbibe — inhibiting their ability to fall in love and stay in love. And if patterns of human love subtlely change, all sorts of social and political atrocities can escalate.

PAUL DAVIES
Physicist, Macquarie University, Sydney; Author, How to Build a Time Machine

The fight against global warming is lost

Some countries, including the United States and Australia, have been in denial about global warming. They cast doubt on the science that set alarm bells ringing. Other countries, such as the UK, are in panic, and want to make drastic cuts in greenhouse emissions. Both stances are irrelevant, because the fight is a hopeless one anyway. In spite of the recent hike in the price of oil, the stuff is still cheap enough to burn. Human nature being what it is, people will go on burning it until it starts running out and simple economics puts the brakes on. Meanwhile the carbon dioxide levels in the atmosphere will just go on rising. Even if developed countries rein in their profligate use of fossil fuels, the emerging Asian giants of China and India will more than make up the difference. Rich countries, whose own wealth derives from decades of cheap energy, can hardly preach restraint to developing nations trying to climb the wealth ladder. And without the obvious solution — massive investment in nuclear energy — continued warming looks unstoppable.

Campaigners for cutting greenhouse emissions try to scare us by proclaiming that a warmer world is a worse world. My dangerous idea is that it probably won't be. Some bad things will happen. For example, the sea level will rise, drowning some heavily populated or fertile coastal areas. But in compensation Siberia may become the world's breadbasket. Some deserts may expand, but others may shrink. Some places will get drier, others wetter. The evidence that the world will be worse off overall is flimsy. What is certainly the case is that we will have to adjust, and adjustment is always painful. Populations will have to move. In 200 years some currently densely populated regions may be deserted. But the population movements over the past 200 years have been dramatic too. I doubt if anything more drastic will be necessary. Once it dawns on people that, yes, the world really is warming up and that, no, it doesn't imply Armageddon, then the international agreements like the Kyoto protocol will fall apart.

The idea of giving up the global warming struggle is dangerous because it shouldn't have come to this. Mankind does have the resources and the technology to cut greenhouse gas emission. What we lack is the political will. People pay lip service to environmental responsibility, but they are rarely prepared to put their money where their mouth is. Global warming may turn out to be not so bad after all, but many other acts of environmental vandalism are manifestly reckless: the depletion of the ozone layer, the destruction of rain forests, the pollution of the oceans. Giving up on global warming will set an ugly precedent.

APRIL GORNIK
Artist, New York City; Danese Gallery

The exact effect of art can't be controlled or fully anticipated

Great art makes itself vulnerable to interpretation, which is one reason that it keeps being stimulating and fascinating for generations. The problem inherent in this is that art could inspire malevolent behavior, as per the notion popularly expressed by *A Clockwork Orange*. When I was young, aspiring to be a conceptual artist, it disturbed me greatly that I couldn't control the interpretation of my work. When I began painting, it was even worse; even I wasn't completely sure of what my art meant. That seemed dangerous for me, personally, at that time. I gradually came not only to respect the complexity and inscrutability of painting and art, but to see how it empowers the object. I believe that works of art are animated by their creators, and remain able to generate thoughts, feelings, responses. However, the fact is that the exact effect of art can't be controlled or fully anticipated.

JAMSHED BHARUCHA

Professor of Psychology, Provost, Senior Vice President, Tufts University

The more we discover about cognition and the brain, the more we will realize that education as we know it does not accomplish what we believe it does

It is not my purpose to echo familiar critiques of our schools. My concerns are of a different nature and apply to the full spectrum of education, including our institutions of higher education, which arguably are the finest in the world.

Our understanding of the intersection between genetics and neuroscience (and their behavioral correlates) is still in its infancy. This century will bring forth an explosion of new knowledge on the genetic and environmental determinants of cognition and brain development, on what and how we learn, on the neural basis of human interaction in social and political contexts, and on variability across people.

Are we prepared to transform our educational institutions if new science challenges cherished notions of what and how we learn? As we acquire the ability to trace genetic and environmental influences on the development of the brain, will we as a society be able to agree

on what our educational objectives should be?

Since the advent of scientific psychology we have learned a lot about learning. In the years ahead we will learn a lot more that will continue to challenge our current assumptions. We will learn that some things we currently assume are learnable are not (and vice versa), that some things that are learned successfully don't have the impact on future thinking and behavior that we imagine, and that some of the learning that impacts future thinking and behavior is not what we spend time teaching. We might well discover that the developmental time course for optimal learning from infancy through the life span is not reflected in the standard educational time line around which society is organized. As we discover more about the gulf between how we learn and how we teach, hopefully we will also discover ways to redesign our systems — but I suspect that the latter will lag behind the former.

Our institutions of education certify the mastery of spheres of knowledge valued by society. Several questions will become increasingly pressing, and are even pertinent today. How much of this learning persists beyond the time at which acquisition is certified? How does this learning impact the lives of our students? How central is it in shaping the thinking and behavior we would like to see among educated people as they navigate, negotiate and lead in an increasingly complex world?

We know that tests and admissions processes are selection devices that sort people into cohorts on the basis of excellence on various dimensions. We know less about how much even our finest examples of teaching contribute to human development over and above selection and motivation.

Even current knowledge about cognition (specifically, our understanding of active learning, memory, attention, and implicit learning) has not fully penetrated our educational practices, because of inertia as well as a natural lag in the application of basic research. For example, educators recognize that active learning is superior to the passive transmission of knowledge. Yet we have a long way to go to adapt our educational practices to what we already know about active learning.

We know from research on memory that learning trials bunched up in time produce less long term retention than the same learning trials spread over time. Yet we compress learning into discrete packets called courses, we test learning at the end of a course of study, and then we move on. Furthermore, memory for both facts and methods of analytic reasoning are context-dependent. We don't know how much of this learning endures, how well it transfers to contexts different from the ones in which the learning occurred, or how it influences future thinking.

At any given time we attend to only a tiny subset of the information in our brains or impinging on our senses. We know from research on attention that information is processed differently by the brain depending upon whether or not it is attended, and that many factors — endogenous and exogenous — control our attention. Educators have been aware of the role of attention in learning, but we are still far from understanding how to incorporate this knowledge into educational design. Moreover, new information presented in a learning situation is interpreted and encoded in terms of prior knowledge and experience; the

increasingly diverse backgrounds of students placed in the same learning contexts implies that the same information may vary in its meaningfulness to different students and may be recalled differently.

Most of our learning is implicit, acquired automatically and unconsciously from interactions with the physical and social environment. Yet language — and hence explicit, declarative or consciously articulated knowledge — is the currency of formal education.

Social psychologists know that what we say about why we think and act as we do is but the tip of a largely unconscious iceberg that drives our attitudes and our behavior. Even as cognitive and social neuroscience reveals the structure of these icebergs under the surface of consciousness (for example, persistent cognitive illusions, decision biases and perceptual biases to which even the best educated can be unwitting victims), it will be less clear how to shape or redirect these knowledge icebergs under the surface of consciousness.

Research in social cognition shows clearly that racial, cultural and other social biases get encoded automatically by internalizing stereotypes and cultural norms. While we might learn about this research in college, we aren't sure how to counteract these factors in the very minds that have acquired this knowledge.

We are well aware of the power of non-verbal auditory and visual information, which when amplified by electronic media capture the attention of our students and sway millions. Future research should give us a better understanding of nuanced non-verbal forms of communication, including their universal and culturally based aspects, as they are manifest in social, political and artistic contexts.

Even the acquisition of declarative knowledge through language — the traditional domain of education — is being usurped by the internet at our finger tips. Our university libraries and publication models are responding to the opportunities and challenges of the information age. But we will need to rethink some of our methods of instruction too. Will our efforts at teaching be drowned out by information from sources more powerful than even the best classroom teacher?

It is only a matter of time before we have brain-related technologies that can alter or supplement cognition, influence what and how we learn, and increase competition for our limited attention. Imagine the challenges for institutions of education in an environment in which these technologies are readily available, for better or worse.

The brain is a complex organ, and we will discover more of this complexity. Our physical, social and information environments are also complex and are becoming more so through globalization and advances in technology. There will be no simple design principles for how we structure education in response to these complexities.

As elite colleges and universities, we see increasing demand for the branding we confer, but we will also see greater scrutiny from society for the education we deliver. Those of us in positions of academic leadership will need wisdom and courage to examine, transform and

justify our objectives and methods as educators.

JORDAN POLLACK

Computer Scientist, Brandeis University

Science as just another Religion

We scientists like to think that our "way of knowing" is special. Instead of holding beliefs based on faith in invisible omniscient deities, or parchments transcribed from oral cultures, we use the scientific method to discover and know. Truth may be eternal, but human knowledge of that truth evolves over time, as new questions are asked, data is recorded, hypotheses are tested, and replication and refutation mechanisms correct the record.

So it is a very dangerous idea to consider Science as just another Religion. It's not my idea, but one I noticed growing in a set of Lakovian Frames within the Memesphere.

One of the frame is that scientists are doom and gloom prophets. For example, at a recent popular technology conference, a parade of speakers spoke about the threats of global warming, the sea level rising by 18 feet and destroying cities, more category 5 hurricanes, etc. It was quite a reversal from the positivistic techno-utopian promises of miraculous advances in medicine, computers, and weaponry that have allowed science to bloom in the late 20th century. A friend pointed out that — in the days before Powerpoint — these scientists might be wearing sandwich-board signs saying "The End is Near!"

Another element in the framing of science as a religion is the response to evidence-based policy. Scientists who do take political stands on "moral" issues such as stem-cell research, death penalty, nuclear weapons, global warming, etc., can be sidelined as atheists, humanists, or agnostics who have no moral or ethical standing outside their narrow specialty (as compared to, say, televangelist preachers.)

A third, and the most nefarious frame, casts theory as one opinion among others which should represented out of fairness or tolerance. This is the subterfuge used by Intelligent Design Creationists.

We may believe in the separation of church and state, but that firewall has fallen. Science and Reason are losing political battles to Superstition and Ignorance. Politics works by rewarding friends and punishing enemies, and while our individual votes may be private, exit polls have

proven that Science didn't vote for the incumbent.

There seem to be three choices going forward: Reject, Accommodate, or Embrace.

One path is to go on an attack on religion in the public sphere. In his book *End of Faith*, Sam Harris points out that humoring people who believe in God is like humoring people who believe that "a diamond [] the size of a refrigerator" is buried in their back yard. There is a fine line between pushing God out of our public institutions and repeating religious intolerance of regimes past.

A second is to embrace Faith-Based Science. Since, from the perspective of government, research just another special interest feeding at the public trough, we should change our model to be more accommodating to political reality. Research is already sold like highway construction projects, with a linear accelerator for your state and a supercomputer center for mine, all done through direct appropriations. All that needs to change is the justifications for such spending.

How would Faith-Based Science work? Well, Physics could sing the psalm that Perpetual Motion would solve the energy crisis, thereby triggering a $500 billion program in free energy machines. (Of course, God is on our side to repeal the Second Law of Thermodynamics!) Astronomy could embrace Astrology and do grassroots PR through Daily Horoscopes to gain mass support for a new space program. In fact, an anti-gravity initiative could pass today if it were spun as a repeal of the "heaviness tax." Using the renaming principle, the SETI program can be re-legalized and brought back to life as the "Search for God" project.

Finally, the third idea is to actually *embrace* this dangerous idea and organize a new open-source spiritual and moral movement. I think a new, greener religion, based on faith in the Gaia Hypothesis and an 11th commandment to "Protect the Earth" could catch on, especially if welcoming to existing communities of faith. Such a movement could be a new pulpit from which the evidence-based silent majority can speak with both moral force and evangelical fervor about issues critical to the future of our planet.

JUAN ENRIQUEZ
CEO, Biotechonomy; Founding Director, Harvard Business School's Life Sciences Project; Author, The Untied States of America

Technology can untie the U.S.

Everyone grows and dies; same is true of countries. The only question is how long one postpones the inevitable. In the case of some countries, life spans can be very long, so it is

worth asking is the U.S. in adolescence, middle age, or old age? Do science and technology accelerate or offset demise? And finally "how many stars will be in the U.S. flag in fifty years?"

There has yet to be a single U.S. president buried under the same flag he was born under, yet we oft take continuity for granted. Just as almost no newlyweds expect to divorce, citizens rarely assume their beloved country, flag and anthem might end up an exhibit in an archeology museum. But countries rich and poor, Asian, African, and European have been untying time and again. In the last five decades the number of UN members has tripled. This trend goes way beyond the de-colonization of the 1960s, and it is not exclusive to failed states; it is a daily debate within the United Kingdom, Italy, France, Belgium, the Netherlands, Austria, and many others.

So far the Americas has remained mostly impervious to these global trends, but, even if in God you trust, there are no guarantees. Over the next decade waves of technology will wash over the U.S. Almost any applied field you care to look at promises extraordinary change, opportunities, and challenges. (Witness the entries in this edition of *Edge*). How counties adapt to massive, rapid upheaval will go a long way towards determining the eventual outcome. To paraphrase Darwin, it is not the strongest, not the largest, that survive rather it is those best prepared to cope with change.

It is easy to argue that the U.S. could be a larger more powerful country in fifty years. But it is also possible that, like so many other great powers, it could begin to unravel and untie. This is not something that depends on what we do decide to do fifty years hence; to a great extent it depends on what we choose to do, or choose to ignore, today. There are more than a few worrisome trends.

Future ability to generate wealth depends on techno-literacy. But educational excellence, particularly in grammar and high schools is far from uniform, and it is not world class. Time and again the U.S. does poorly, particularly in regards to math and science, when compared with its major trading partners. Internally, there are enormous disparities between schools and between the number of students that pass state competency exams and what federal tests tell us about the same students. There are also large gaps in techno literacy between ethnic groups. By 2050 close to 40% of the U.S. population will be Hispanic and African American. These groups receive 3% of the PhDs in math and science today. How we prepare kids for a life sciences, materials, robotics, IT, and nanotechnology driven world is critical. But we currently invest $22,000 federal dollars in those over 65 and just over $2,000 in those under sixteen...

As ethnic, age, and regional gaps in the ability to adapt increase there are many wary and frustrated by technology, open borders, free trade, and smart immigrants. Historically, when others use newfangled ways to leap ahead, it can lead to a conservative response. This is likeliest within those societies and groups thant have the most to lose, often among those who have been the most successful. One often observes a reflexive response: stop the train; I want to get off. Or, as the Red Sox now say, just wait till last year. No more teaching evolution, no more research into stem cells, no more Indian or Chinese or Mexican immigrants, no matter how smart or hardworking they might be. These individual battles are signs of a creeping xenophobia, isolationism, and fury.

Within the U.S. there are many who are adapting very successfully. They tend to concentrate in a very few zip codes, life science clusters like 92121(between Salk, Scripps, and UCSD) and techno-empires like 02139 (MIT). Most of the nation's wealth and taxes are generated by a few states and, within these states, within in a few square miles. It is those who live in these areas that are most affronted by restrictions on research, the lack of science literate teenagers, and the reliance on God instead of science.

Politicians well understand these divides and they have gerrymandered their own districts to reflect them. Because competitive congressional elections are rarer today than turnovers within the Soviet Politburo, there is rarely an open debate and discussion as to why other parts of the country act and think so differently. The Internet and cable further narrowcast news and views, tending to reinforce what one's neighbors and communities already believe. Positions harden. Anger at "the others" mounts.

Add a large and mounting debt to this equation, along with politicized religion, and the mixture becomes explosive. The average household now owes over $88,000 and the present value of what we have promised to pay is now about $473,000. There is little willingness within Washington to address a mounting deficit, never mind the current account imbalance. Facing the next electoral challenge, few seem to remember the last act of many an empire is to drive itself into bankruptcy.

Sooner or later we could witness some very bitter arguments about who gets and who pays. In developed country after developed country, it is often the richest, not the ethnically or religiously repressed, that first seek autonomy and eventually dissolution. In this context it is worth recalling that New England, not the South, has been the most secession prone region. As the country expanded, New Englanders attempted to include the right to untie into the constitution; the argument was that as this great country expanded South and West they would lose control over their political and economic destiny. Perhaps this is what led to four separate attempts to untie the Union.

When we assume stability and continuity we can wake up to irreconcilable differences. Science and a knowledge driven economy can allow a few folks to build powerful and successful countries very quickly, witness Korea, Taiwan, Singapore, Ireland, but changes of this magnitude can also bury or split the formerly great who refuse to adapt, as well as those who practice bad governance. If we do not begin to address some current divides quickly we could live to see an Un-Tied States of America.

STEPHEN M. KOSSLYN
Psychologist, Harvard University; Author, Wet Mind

A Science of the Divine?

Here's an idea that many academics may find unsettling and dangerous: God exists. And here's another idea that many religious people may find unsettling and dangerous: God is not supernatural, but rather part of the natural order. Simply stating these ideas in the same breath invites them to scrape against each other, and sparks begin to fly. To avoid such conflict, Stephen Jay Gould famously argued that we should separate religion and science, treating them as distinct "magisteria." But science leads many of us to try to understand all that we encounter with a single, grand and glorious overarching framework. In this spirit, let me try to suggest one way in which the idea of a "supreme being" can fit into a scientific worldview.

I offer the following not to advocate the ideas, but rather simply to illustrate one (certainly not the only) way that the concept of God can be approached scientifically.

1.0. First, here's the specific conception of God I want to explore: God is a "supreme being" that transcends space and time, permeates our world but also stands outside of it, and can intervene in our daily lives (partly in response to prayer).

2.0. A way to begin to think about this conception of the divine rests on three ideas:

2.1. Emergent properties. There are many examples in science where aggregates produce an entity that has properties that cannot be predicted entirely from the elements themselves. For example, neurons in large numbers produce minds; moreover, minds in large numbers produce economic, political, and social systems.

2.2. Downward causality. Events at "higher levels" (where emergent properties become evident) can in turn feed back and affect events at lower levels. For example, chronic stress (a mental event) can cause parts of the brain to become smaller. Similarly, an economic depression or the results of an election affect the lives of the individuals who live in that society.

2.3. The Ultimate Superset. The Ultimate Superset (superordinate set) of all living things may have an equivalent status to an economy or culture. It has properties that emerge from the interactions of living things and groups of living things, and in turn can feed back to affect those things and groups.

3.0. Can we conceive of God as an emergent property of all living things that can in turn affect its constituents? Here are some ways in which this idea is consistent with the nature of God, as outlined at the outset.

3.1. This emergent entity is "transcendent" in the sense that it exists in no specific place or time. Like a culture or an economy, God is nowhere, although the constituent elements occupy specific places. As for transcending time, consider this analogy: Imagine that 1/ 100th of the neurons in your brain were replaced every hour, and each old neuron programmed a new one so that the old one's functionality was preserved. After 100 hours your brain would be an entirely new organ — but your mind would continue to exist as it had been before.

Similarly, as each citizen dies and is replaced by a child, the culture continues to exist (and can grow and develop, with a "life of its own"). So too with God. For example, in the story of Jacob's ladder, Jacob realizes "Surely the *Lord* is in this place, and I did not know it." (Genesis 28: 16) I interpret this story as illustrating that God is everywhere but nowhere. The Ultimate Superset permeates our world but also stands outside of (or, more specifically, "above") it.

3.2. The Ultimate Superset can affect our individual lives. Another analogy: Say that geese flying south for the winter have rather unreliable magnetic field detectors in their brains. However, there's a rule built into their brains that leads them to try to stay near their fellows as they fly. The flock as a whole would navigate far better than any individual bird, because the noise in the individual bird brain navigation systems would cancel out. The emergent entity — the flock — in turn would affect the individual geese, helping them to navigate better than they could on their own.

3.3. When people pray to the Lord, they beseech intervention on their or others' behalf. The view that I've been outlining invites us to think of the effects of prayer as akin to becoming more sensitive to the need to stay close to the other birds in the flock: By praying, one can become more sensitive to the emergent "supreme being." Such increased sensitivity may imply that one can contribute more strongly to this emergent entity.

By analogy, it's as if one of those geese became aware of the "keep near" rule, and decided to nudge the other birds in a particular direction — which thereby allows it to influence the flock's effect on itself. To the extent that prayer puts one closer to God, one's plea for intervention will have a larger impact on the way that The Ultimate Superset exerts downward causality. But note that, according to this view, God works rather slowly. Think of dropping rocks in a pond: it takes time for the ripples to propagate and eventually be reflected back from the edge, forming interference patterns in the center of the pond.

4.0. A crucial idea in monotheistic religions is that God is the Creator. The present approach may help us begin to grapple with this idea, as follows.

4.1. First, consider each individual person. The environment plays a key role in creating who and what we are because there are far too few genes to program every aspect of our brains. For example, when you were born, your genes programmed many connections in your visual areas, but did not specify the precise circuits necessary to determine how far away objects are. As an infant, the act of reaching for an object tuned the brain circuits that estimate how far away the object was from you.

Similarly, your genes graced you with the ability to acquire language, but not with a specific language. The act of acquiring a language shapes your brain (which in turn may make it difficult to acquire another language, with different sounds and grammar, later in life). Moreover, cultural practices configure the brains of members of the culture. A case in point: the Japanese have many forms of bowing, which are difficult for a Westerner to master relatively late in life; when we try to bow, we "bow with an accent."

4.2. And the environment not only played an essential role in how we developed as children, but also plays a continuing role in how we develop over the course of our lives as adults. The

act of learning literally changes who and what we are.

4.3. According to this perspective, it's not just negotiating the physical world and sociocultural experience that shape the brain: The Ultimate Superset — the emergent property of all living things — affects all of the influences that "make us who and what we are," both as we develop during childhood and continue to learn and develop as adults.

4.4. Next, consider our species. One could try to push this perspective into a historical context, and note that evolution by natural selection reflects the effects of interactions among living things. If so, then the emergent properties of such interactions could feed back to affect the course of evolution itself.

In short, it is possible to begin to view the divine through the lens of science. But such reasoning does no more than set the stage; to be a truly dangerous idea, this sort of proposal must be buttressed by the results of empirical test. At present, my point is not to convince, but rather to intrigue. As much as I admired Stephen Jay Gould (and I did, very much), perhaps he missed the mark on this one. Perhaps there is a grand project waiting to be launched, to integrate the two great sources of knowledge and belief in the world today — science and religion.

JERRY COYNE

Evolutionary Biologist; Professor, Department of Ecology and Evolution, University of Chicago; Author (with H. Allen Orr), Speciation

Many behaviors of modern humans were genetically hard-wired (or soft-wired) in our distant ancestors by natural selection

For me, one idea that is dangerous and possibly true is an extreme form of evolutionary psychology — the view that many behaviors of modern humans were genetically hard-wired (or soft-wired) in our distant ancestors by natural selection.

The reason I say that this idea might be true is that we cannot be sure of the genetic and evolutionary underpinnings of most human behaviors. It is difficult or impossible to test many of the conjectures of evolutionary psychology. Thus, we can say only that behaviors such as the sexual predilections of men versus women, and the extreme competitiveness of males, are consistent with evolutionary psychology.

But consistency arguments have two problems. First, they are not hard scientific proof. Are we satisfied that sonnets are phallic extensions simply because some male poets might have used them to lure females? Such arguments fail to meet the normal standards of scientific

evidence.

Second, as is well known, one can make consistency arguments for virtually every human behavior. Given the possibilities of kin selection (natural selection for behaviors that do no good for to their performers but are advantageous to their relatives) and reciprocal altruism, and our ignorance of the environments of our ancestors, there is no trait beyond evolutionary explanation. Indeed, there are claims for the evolutionary origin of even manifestly maladaptive behaviors, such as homosexuality, priestly celibacy, and extreme forms of altruism (e.g., self-sacrifice during wartime). But surely we cannot consider it scientifically proven that genes for homosexuality are maintained in human populations by kin selection. This remains possible but undemonstrated.

Nevertheless, much of human behavior does seem to conform to Darwinian expectations. Males are promiscuous and females coy. We treat our relatives better than we do other people. The problem is where to draw the line between those behaviors that are so obviously adaptive that no one doubts their genesis (e.g. sleeping and eating), those which are probably but not as obviously adaptive (e.g., human sexual behavior and our fondness for fats and sweets) and those whose adaptive basis is highly speculative (e.g., the origin of art and our love of the outdoors).

Although I have been highly critical of evolutionary psychology, I have not done so from political motives, nor do I think that the discipline is in principle misguided. Rather, I have been critical because evolutionary psychologists seem unwilling to draw lines between what can be taken as demonstrated and what remains speculative, making the discipline more of a faith than a science. This lack of rigor endangers the reputation of all of evolutionary biology, making our endeavors seem to be merely the concoction of ingenious stories. If we are truly to understand human nature, and use this knowledge constructively, we must distinguish the probably true from the possibly true.

So, why do I see evolutionary psychology as dangerous? I think it is because I am afraid to see myself and my fellow humans as mere marionettes dancing on genetic strings. I would like to think that we have immense freedom to better ourselves as individuals and to create a just and egalitarian society. Granted, genetics is not destiny, but neither are we completely free of our evolutionary baggage. Might genetics really hold a leash on our capacity to change? If so, then some claims of evolutionary psychology give us convenient but dangerous excuses for behaviors that seem unacceptable. It is all too easy, for example, for philandering males to excuse their behavior as evolutionarily justified. Evolutionary psychologists argue that it is possible to overcome our evolutionary heritage. But what if it is not so easy to take the Dawkinsian road and "rebel against the tyranny of the selfish replicators"?

ERNST PÖPPEL
Neuroscientist, Chairman, Board of Directors, Human Science Center and Department of Medical Psychology, Munich University, Germany; Author, Mindworks

My belief in science

Average life expectancy of a species on this globe is just a few million years. From an external point of view, it would be nothing special if humankind suddenly disappears. We have been here for sometime. With humans no longer around, evolutionary processes would have an even better chance to fill in all those ecological niches which have been created by human activities. As we change the world, and as thousands of species are lost every year because of human activities, we provide a new and productive environment for the creation of new species. Thus, humankind is very creative with respect to providing a frame for new evolutionary trajectories, and humankind would even be more creative, if it has disappeared altogether. If somebody (unfortunately not our descendents) would visit this globe some time later, they would meet many new species, which owe their existence the presence and the disappearance of humankind.

But this is not going to happen, because we are doing science. With science we apparently get a better understanding of basic principles in nature, we have a chance to improve quality of life, and we can develop means to extend the life expectancy of our species. Unfortunately, some of these scientific activities have a paradoxical effect resulting in a higher risk for a common disappearance. Maybe, science will not be so effective after all to prevent our disappearance.

Only now comes my dangerous idea as my (!) dangerous idea. It is not so difficult to come up with a dangerous scenario on a general level, but if one takes such a question also seriously on a personal level, one has to meditate an individual scenario. I am very grateful for this question formulated by Steven Pinker as it forced me to visit my episodic memory and to think about what has been and still is "my dangerous idea". Although nobody else might be interested in a personal statement, I say it anyway: My dangerous idea is my belief in science.

In all my research (in the field of temporal perception or visual processes) I have a basic trust in the scientific activities, and I actually believe the results I have obtained. And I believe the results of others. But why? I know that there so many unknown and unknowable variables that are part of the experimental setup and which cannot be controlled. How can I trust in spite of so many unknowables (does this word exist in English?)? Furthermore, can I really rely on my thinking, can I trust my eyes and ears? Can I be so sure about my scientific activities that I communicate with pride the results to others? If I look at the complexity of the brain, how is it possible that something reasonable comes out of this network? How is it possible that a face that I see or a thought that I have maintain their identity over time? If I have no access to what goes on in my brain, how can I be so proud, (how can anybody be so proud) about scientific achievements?

GEOFFREY MILLER
Evolutionary Psychologist, University of New Mexico; Author, The Mating Mind

Runaway consumerism explains the Fermi Paradox

The story goes like this: Sometime in the 1940s, Enrico Fermi was talking about the possibility of extra-terrestrial intelligence with some other physicists. They were impressed that our galaxy holds 100 billion stars, that life evolved quickly and progressively on earth, and that an intelligent, exponentially-reproducing species could colonize the galaxy in just a few million years. They reasoned that extra-terrestrial intelligence should be common by now. Fermi listened patiently, then asked simply, "So, where is everybody?". That is, if extra-terrestrial intelligence is common, why haven't we met any bright aliens yet? This conundrum became known as Fermi's Paradox.

The paradox has become more ever more baffling. Over 150 extrasolar planets have been identified in the last few years, suggesting that life-hospitable planets orbit most stars. Paleontology shows that organic life evolved very quickly after earth's surface cooled and became life-hospitable. Given simple life, evolution shows progressive trends towards larger bodies, brains, and social complexity. Evolutionary psychology reveals several credible paths from simpler social minds to human-level creative intelligence. Yet 40 years of intensive searching for extra-terrestrial intelligence have yielded nothing. No radio signals, no credible spacecraft sightings, no close encounters of any kind.

So, it looks as if there are two possibilities. Perhaps our science over-estimates the likelihood of extra-terrestrial intelligence evolving. Or, perhaps evolved technical intelligence has some deep tendency to be self-limiting, even self-exterminating. After Hiroshima, some suggested that any aliens bright enough to make colonizing space-ships would be bright enough to make thermonuclear bombs, and would use them on each other sooner or later. Perhaps extra-terrestrial intelligence always blows itself up. Fermi's Paradox became, for a while, a cautionary tale about Cold War geopolitics.

I suggest a different, even darker solution to Fermi's Paradox. Basically, I think the aliens don't blow themselves up; they just get addicted to computer games. They forget to send radio signals or colonize space because they're too busy with runaway consumerism and virtual-reality narcissism. They don't need Sentinels to enslave them in a Matrix; they do it to themselves, just as we are doing today.

The fundamental problem is that any evolved mind must pay attention to indirect cues of biological fitness, rather than tracking fitness itself. We don't seek reproductive success directly; we seek tasty foods that tended to promote survival and luscious mates who tended to produce bright, healthy babies. Modern results: fast food and pornography. Technology is

fairly good at controlling external reality to promote our real biological fitness, but it's even better at delivering fake fitness — subjective cues of survival and reproduction, without the real-world effects. Fresh organic fruit juice costs so much more than nutrition-free soda. Having real friends is so much more effort than watching Friends on TV. Actually colonizing the galaxy would be so much harder than pretending to have done it when filming Star Wars or Serenity.

Fitness-faking technology tends to evolve much faster than our psychological resistance to it. The printing press is invented; people read more novels and have fewer kids; only a few curmudgeons lament this. The Xbox 360 is invented; people would rather play a high-resolution virtual ape in Peter Jackson's King Kong than be a perfect-resolution real human. Teens today must find their way through a carnival of addictively fitness-faking entertainment products: MP3, DVD, TiVo, XM radio, Verizon cellphones, Spice cable, EverQuest online, instant messaging, Ecstasy, BC Bud. The traditional staples of physical, mental, and social development (athletics, homework, dating) are neglected. The few young people with the self-control to pursue the meritocratic path often get distracted at the last minute — the MIT graduates apply to do computer game design for Electronics Arts, rather than rocket science for NASA.

Around 1900, most inventions concerned physical reality: cars, airplanes, zeppelins, electric lights, vacuum cleaners, air conditioners, bras, zippers. In 2005, most inventions concern virtual entertainment — the top 10 patent-recipients are usually IBM, Matsushita, Canon, Hewlett-Packard, Micron Technology, Samsung, Intel, Hitachi, Toshiba, and Sony — not Boeing, Toyota, or Wonderbra. We have already shifted from a reality economy to a virtual economy, from physics to psychology as the value-driver and resource-allocator. We are already disappearing up our own brainstems. Freud's pleasure principle triumphs over the reality principle. We narrow-cast human-interest stories to each other, rather than broad-casting messages of universal peace and progress to other star systems.

Maybe the bright aliens did the same. I suspect that a certain period of fitness-faking narcissism is inevitable after any intelligent life evolves. This is the Great Temptation for any technological species — to shape their subjective reality to provide the cues of survival and reproductive success without the substance. Most bright alien species probably go extinct gradually, allocating more time and resources to their pleasures, and less to their children.

Heritable variation in personality might allow some lineages to resist the Great Temptation and last longer. Those who persist will evolve more self-control, conscientiousness, and pragmatism. They will evolve a horror of virtual entertainment, psychoactive drugs, and contraception. They will stress the values of hard work, delayed gratification, child-rearing, and environmental stewardship. They will combine the family values of the Religious Right with the sustainability values of the Greenpeace Left.

My dangerous idea-within-an-idea is that this, too, is already happening. Christian and Muslim fundamentalists, and anti-consumerism activists, already understand exactly what the Great Temptation is, and how to avoid it. They insulate themselves from our Creative-Class dream-worlds and our EverQuest economics. They wait patiently for our fitness-faking narcissism to go extinct. Those practical-minded breeders will inherit the earth, as like-minded aliens may

have inherited a few other planets. When they finally achieve Contact, it will not be a meeting of novel-readers and game-players. It will be a meeting of dead-serious super-parents who congratulate each other on surviving not just the Bomb, but the Xbox. They will toast each other not in a soft-porn Holodeck, but in a sacred nursery.

ROBERT SHAPIRO
Professor Emeritus, Senior Research Scientist, Department of Chemistry, New York University. Author, Planetary Dreams

We shall understand the origin of life within the next 5 years

Two very different groups will find this development dangerous, and for different reasons, but this outcome is best explained at the end of my discussion.

Just over a half century ago, in the spring of 1953, a famous experiment brought enthusiasm and renewed interest to this field. Stanley Miller, mentored by Harold Urey, demonstrated that a mixture of small organic molecules (monomers) could readily be prepared by exposing a mixture of simple gases to an electrical spark. Similar mixtures were found in meteorites, which suggested that organic monomers may be widely distributed in the universe. If the ingredients of life could be made so readily, then why could they not just as easily assort themselves to form cells?

In that same spring, however, another famous paper was published by James Watson and Francis Crick. They demonstrated that the heredity of living organisms was stored in a very large large molecule called DNA. DNA is a polymer, a substance made by stringing many smaller units together, as links are joined to form a long chain.

The clear connection between the structure of DNA and its biological function, and the geometrical beauty of the DNA double helix led many scientists to consider it to be the essence of life itself. One flaw remained, however, to spoil this picture. DNA could store information, but it could not reproduce itself without the assistance of proteins, a different type of polymer. Proteins are also adept at increasing the rate of (catalyzing) many other chemical reactions that are considered necessary for life. The origin of life field became mired in the "chicken-or-the egg" question. Which came first: DNA or proteins? An apparent answer emerged when it was found that another polymer, RNA (a cousin of DNA) could manage both heredity and catalysis. In 1986, Walter Gilbert proposed that life began with an "RNA World." Life started when an RNA molecule that could copy itself was formed, by chance, in a pool of its own building blocks.

Unfortunately, a half century of chemical experiments have demonstrated that nature has no

inclination to prepare RNA, or even the building blocks (nucleotides) that must be linked together to form RNA. Nucleotides are not formed in Miller-type spark discharges, nor are they found in meteorites. Skilled chemists have prepared nucleotides in well-equipped laboratories, and linked them to form RNA, but neither chemists nor laboratories were present when life began on the early Earth. The Watson-Crick theory sparked a revolution in molecular biology, but it left the origin-of-life question at an impasse.

Fortunately, an alternative solution to this dilemma has gradually emerged: neither DNA nor RNA nor protein were necessary for the origin of life. Large molecules dominate the processes of life today, but they were not needed to get it started. Monomers themselves have the ability to support heredity and catalysis. The key requirement is that a suitable energy source be available to assist them in the processes of self-organization. A demonstration of the principle involved in the origin of life would require only that a suitable monomer mixture be exposed to an appropriate energy source in a simple apparatus. We could then observe the very first steps in evolution.

Some mixtures will work, but many others will fail, for technical reasons. Some dedicated effort will be needed in the laboratory to prove this point. Why have I specified five years for this discovery? The unproductive polymer-based paradigm is far from dead, and continues to consume the efforts of the majority of workers in the field. A few years will be needed to entice some of them to explore the other solution. I estimate that several years more (the time for a PhD thesis) might be required to identify a suitable monomer-energy combination, and perform a convincing demonstration.

Who would be disturbed if such efforts should succeed? Many scientists have been attracted by the RNA World theory because of its elegance and simplicity. Some of them have devoted decades of their career in efforts to prove it. They would not be pleased if Freeman Dyson's description proved to be correct: "life began with little bags, the precursors of cells, enclosing small volumes of dirty water containing miscellaneous garbage."

A very different group would find this development as dangerous as the theory of evolution. Those who advocate creationism and intelligent design would feel that another pillar of their belief system was under attack. They have understood the flaws in the RNA World theory, and used them to support their supernatural explanation for life's origin. A successful scientific theory in this area would leave one less task less for God to accomplish: the origin of life would be a natural (and perhaps frequent) result of the physical laws that govern this universe. This latter thought falls directly in line with the idea of Cosmic Evolution, which asserts that events since the Big Bang have moved almost inevitably in the direction of life. No miracle or immense stroke of luck was needed to get it started. If this should be the case, then we should expect to be successful when we search for life beyond this planet. We are not the only life that inhabits this universe.

KAI KRAUSE
Researcher, philosopher, software developer, Author: 3D Science: new Scanning Electron Microscope imagery

Anty Gravity: Chaos Theory in an all too practical sense

Dangerous Ideas? It is dangerous ideas you want? From this group of people ? That in itself ought to be nominated as one of the more dangerous ideas...

Danger is ubiquitous. If recent years have shown us anything, it should be that "very simple small events can cause real havoc in our society". A few hooded youths play cat and mouse with the police: bang, thousands of burned cars put all of Paris into a complete state of paralysis, mandatory curfew and the entire system in shock and horror.

My first thought was: what if any *really* smart set of people really set their mind to it...how utterly and scarily trivial it would be, to disrupt the very fabric of life, to bring society to a dead stop?

The relative innocence and stable period of the last 50 years may spiral into a nearly inevitable exposure to real chaos. What if it isn't haphazard testosterone driven riots, where they cannibalize their own neighborhood, much like in L.A. in the 80s, but someone with real insight behind that criminal energy ? What if Slashdotters start musing aloud about "Gee, the L.A. water supply is rather simplistic, isn't it?" An Open Source crime web, a Wiki for real WTO opposition ? Hacking L.A. may be a lot easier than hacking IE.

That is basic banter over a beer in a bar, I don't even want to actually speculate what a serious set of brainiacs could conjure up. And I refuse to even give it any more print space here. However, the danger of such sad memes is what requires our attention!

In fact, I will broaden the specter still: its not violent crime and global terrorism I worry about, as much as the basic underpinning of our entire civilization coming apart, as such. No acts of malevolence, no horrible plans by evil dark forces, neither the singular "Bond Nemesis" kind, nor masses of religious fanatics. None of that needed... It is the *glue* that is coming apart to topple this tower. And no, I am not referring to "spiraling trillions of debt".

No, what I am referring to is a slow process I observed over the last 30 years, ever since in my teens I wondered "How would this world work, if everyone were like me ?" and realized: it wouldn't !

It was amazing to me that there were just enough people to make just enough shoes so that everyone can avoid walking barefoot. That there are people volunteering to spend day-in, day-out, being dentists, and lawyers and salesmen. Almost *any* "jobjob" I look at, I have the most sincere admiration for the tenacity of the people...how *do* they do it? It would drive me nuts

after *hours*, let alone years...Who makes those shoes ?

That was the wondrous introspection in adolescent phases, searching for a place in the jigsaw puzzle.

But in recent years, the haunting question has come back to me: "How the hell *does* this world function at all? And does it, really ? I feel an alienation zapping through the channels, I can't find myself connecting with those groups of humanoids trouncing around MTV. Especially the glimpses of "real life": on daytime-courtroom-dramas or just looking at faces in the street. On every scale, the closer I observe it, the more the creeping realization haunts me: individuals, families, groups, neighborhoods, cities, states, countries... they all just barely hang in there, between debt and dysfunction. The whole planet looks like Any town with mini malls cutting up the landscape and just down the road it's all white trash with rusty car wrecks in the back yard. A huge Groucho Club I don't want to be a member of.

But it does go further: what is particularly disturbing to see is this desperate search for Individualism that has rampantly increased in the last decade or so.

Everyone suddenly needs to be *so* special, be utterly unique. So unique that they race off like lemmings to get 'even more individual' tattoos, branded cattle, with branded chains in every mall, converging on a blanded sameness world wide, but every rap singer with ever more gold chains in ever longer stretched limos is singing the tune: Don't be a loser! Don't be normal! The desperation with which millions of youngsters try to be that one-in-a-million professional ball player may have been just a "sad but silly factoid" for a long time.

But now the tables are turning: the anthill is relying on the behaviour of the ants to function properly. And that implies: the social behaviour, the role playing, taking defined tasks and follow them through.

What if each ant suddenly wants to be the queen? What if soldiering and nest building and cleaning chores is just not cool enough any more?

If AntTV shows them every day nothing but *un*-Ant behaviour...?

In my youth we were whining about what to do and how to do it, but in the end,all of my friends did become "normal" humans, orthopedics and lawyers, social workers, teachers... There were always a few that lived on the edges of normality, like ending up as television celebrities, but on the whole: they were perfectly reasonable ants. 1.8 children, 2.7 cars, 3.3 TVs...

Now: I am no longer confident that line will continue. If every honeymoon is now booked in Bali on a Visa card, and every kid in Borneo wants to play ball in NYC... can the network of society be pliable enough to accommodate total upheaval? And what if 2 billion Chinese and Indians raise a generation of kids staring 6+ hours a day into All American values they can never attain... being taunted with Hollywood movies of heroic acts and pathetic

dysfunctionality, coupled with ever increasing violence and disdain for ethics or morals.

Seeing scenes of desperate youths in South American slums watching "Kill Bill" makes me think: this is just oxygen thrown into the fire... The ants will not play along much longer. The anthill will not survive if even a small fraction of the system is falling apart.

Couple that inane drive for "Super Individualism" (and the Quest for Coolness by an ever increasing group destined to fail miserably) with the scarily simple realization of how effective even a small set of desperate people can become, then add the obvious penchant for religious fanaticism and you have an ugly picture of the long term future.

So many curves that grow upwards towards limits, so many statistics that show increases and no way to turn around.

Many in this forum may speculate about infinite life spans, changing the speed of light, finding ways to decode consciousness, wormholes to other dimensions and finding grand unified theories.

To make it clear: I applaud that! "It does take all kinds".
Diversity is indeed one of the definitions of the meaning of life.
Edge IS Applied Diversity.

Those are viable and necessary questions for mankind as a whole, however: I believe we need to clean house, re-evaluate, redefine the priorities.

While we look at the horizon here in these pages, it is the very ground beneath us, that may be crumbling. The ant hill could really go to ant hell! Next year, let's ask for *good* ideas. Really practical, serious, *good ideas*. "The most immediate positive global impact of any kind that can be achieved within one year?". How to envision Internet3 and Web3 as a real platform for a global brainstorming with 6+ billion potential participants.

This was not meant to sound like doom and gloom naysaying. I see myself as a sincere optimist, but one who believes in realistic pessimism as a useful tool to initiate change.

CARLO ROVELLI
Professor of Physics, University of the Mediterraneum, Marseille; Member, Intitut Universitaire de France: Author, Quantum Gravity

What the physics of the 20th century says about the world might in fact be true

There is a major "dangerous" scientific idea in contemporary physics, with a potential impact comparable to Copernicus or Darwin. It is the idea that what the physics of the 20th century says about the world might in fact be true.

Let me explain. Take quantum mechanics. If taken seriously, it changes our understanding of reality truly dramatically. For instance, if we take quantum mechanics seriously, we cannot think that objects have ever a definite position. They have a positions only when they interact with something else. And even in this case, they are in that position only with respect to that "something else": they are still without position with respect to the rest of the world. This is a change of image of the world far more dramatic that Copernicus. And also a change about our possibility of thinking about ourselves far more far-reaching than Darwin. Still, few people take the quantum revolution really seriously. The danger is exorcized by saying "well, quantum mechanics is only relevant for atoms and very small objects...", or similar other strategies, aimed at not taking the theory seriously. We still haven't digested that the world is quantum mechanical, and the immense conceptual revolution needed to make sense of this basic factual discovery about nature.

Another example: take Einstein's relativity theory. Relativity makes completely clear that asking "what happens right now on Andromeda?" is a complete non-sense. There is no right now elsewhere in the universe. Nevertheless, we keep thinking at the universe as if there was an immense external clock that ticked away the instants, and we have a lot of difficulty in adapting to the idea that "the present state of the universe right now", is a physical non-sense.

In these cases, what we do is to use concepts that we have developed in our very special environment (characterized by low velocities, low energy...) and we think the world as if it was all like that. We are like ants that have grown in a little garden with green grass and small stones, and cannot think reality differently than made of green grass and small stones.

I think that seen from 200 years in the future, the dangerous scientific idea that was around at the beginning of the 20th century, and that everybody was afraid to accept, will simply be that the world is completely different from our simple minded picture of it. As the physics of the 20th century had already shown.

What makes me smile is that even many of todays "audacious scientific speculations" about things like extra-dimensions, multi-universes, and the likely, are not only completely unsupported experimentally, but are even always formulated within world view that, at a close look, has not yet digested quantum mechanics and relativity!

RICHARD DAWKINS
Evolutionary Biologist, Charles Simonyi Professor For The Understanding Of Science, Oxford University; Author, The Ancestor's Tale

Let's all stop beating Basil's car

Ask people why they support the death penalty or prolonged incarceration for serious crimes, and the reasons they give will usually involve retribution. There may be passing mention of deterrence or rehabilitation, but the surrounding rhetoric gives the game away. People want to kill a criminal as payback for the horrible things he did. Or they want to give "satisfaction' to the victims of the crime or their relatives. An especially warped and disgusting application of the flawed concept of retribution is Christian crucifixion as "atonement' for "sin'.

Retribution as a moral principle is incompatible with a scientific view of human behaviour. As scientists, we believe that human brains, though they may not work in the same way as man-made computers, are as surely governed by the laws of physics. When a computer malfunctions, we do not punish it. We track down the problem and fix it, usually by replacing a damaged component, either in hardware or software.

Basil Fawlty, British television's hotelier from hell created by the immortal John Cleese, was at the end of his tether when his car broke down and wouldn't start. He gave it fair warning, counted to three, gave it one more chance, and then acted. "Right! I warned you. You've had this coming to you!" He got out of the car, seized a tree branch and set about thrashing the car within an inch of its life. Of course we laugh at his irrationality. Instead of beating the car, we would investigate the problem. Is the carburettor flooded? Are the sparking plugs or distributor points damp? Has it simply run out of gas? Why do we not react in the same way to a defective man: a murderer, say, or a rapist? Why don't we laugh at a judge who punishes a criminal, just as heartily as we laugh at Basil Fawlty? Or at King Xerxes who, in 480 BC, sentenced the rough sea to 300 lashes for wrecking his bridge of ships? Isn't the murderer or the rapist just a machine with a defective component? Or a defective upbringing? Defective education? Defective genes?

Concepts like blame and responsibility are bandied about freely where human wrongdoers are concerned. When a child robs an old lady, should we blame the child himself or his parents? Or his school? Negligent social workers? In a court of law, feeble-mindedness is an accepted defence, as is insanity. Diminished responsibility is argued by the defence lawyer, who may also try to absolve his client of blame by pointing to his unhappy childhood, abuse by his father, or even unpropitious genes (not, so far as I am aware, unpropitious planetary conjunctions, though it wouldn't surprise me).

But doesn't a truly scientific, mechanistic view of the nervous system make nonsense of the very idea of responsibility, whether diminished or not? Any crime, however heinous, is in principle to be blamed on antecedent conditions acting through the accused's physiology, heredity and environment. Don't judicial hearings to decide questions of blame or diminished

responsibility make as little sense for a faulty man as for a Fawlty car?

Why is it that we humans find it almost impossible to accept such conclusions? Why do we vent such visceral hatred on child murderers, or on thuggish vandals, when we should simply regard them as faulty units that need fixing or replacing? Presumably because mental constructs like blame and responsibility, indeed evil and good, are built into our brains by millennia of Darwinian evolution. Assigning blame and responsibility is an aspect of the useful fiction of intentional agents that we construct in our brains as a means of short-cutting a truer analysis of what is going on in the world in which we have to live. My dangerous idea is that we shall eventually grow out of all this and even learn to laugh at it, just as we laugh at Basil Fawlty when he beats his car. But I fear it is unlikely that I shall ever reach that level of enlightenment.

SETH LLOYD

Quantum Mechanical Engineer, MIT

The genetic breakthrough that made people capable of ideas themselves

The most dangerous idea is the genetic breakthrough that made people capable of ideas themselves. The idea of ideas is nice enough in principle; and ideas certainly have had their impact for good. But one of these days one of those nice ideas is likely to have the unintended consequence of destroying everything we know.

Meanwhile, we cannot not stop creating and exploring new ideas: the genie of ingenuity is out of the bottle. To suppress the power of ideas will hasten catastrophe, not avert it. Rather, we must wield that power with the respect it deserves.

Who risks no danger reaps no reward.

CAROLYN PORCO

Planetary Scientist; Cassini Imaging Science Team Leader; Director CICLOPS, Boulder CO; Adjunct Professor, University of Colorado, University of Arizona

The Greatest Story Ever Told

The confrontation between science and formal religion will come to an end when the role played by science in the lives of all people is the same played by religion today.

And just what is that?

At the heart of every scientific inquiry is a deep spiritual quest — to grasp, to know, to feel connected through an understanding of the secrets of the natural world, to have a sense of one's part in the greater whole. It is this inchoate desire for connection to something greater and immortal, the need for elucidation of the meaning of the 'self', that motivates the religious to belief in a higher 'intelligence'. It is the allure of a bigger agency — outside the self but also involving, protecting, and celebrating the purpose of the self — that is the great attractor. Every culture has religion. It undoubtedly satisfies a manifest human need.

But the same spiritual fulfillment and connection can be found in the revelations of science. From energy to matter, from fundamental particles to DNA, from microbes to Homo sapiens, from the singularity of the Big Bang to the immensity of the universe .... ours is the greatest story ever told. We scientists have the drama, the plot, the icons, the spectacles, the 'miracles', the magnificence, and even the special effects. We inspire awe. We evoke wonder.

And we don't have one god, we have many of them. We find gods in the nucleus of every atom, in the structure of space/ time, in the counter-intuitive mechanisms of electromagneticsm. What richness! What consummate beauty!

We even exalt the `self'. Our script requires a broadening of the usual definition, but we too offer hope for everlasting existence. The `self' that is the particular, networked set of connections of the matter comprising our mortal bodies will one day die, of course. But the `self' that is the sum of each separate individual condensate in us of energy-turned-matter is already ancient and will live forever. Each fundamental particle may one day return to energy, or from there revert back to matter. But in one form or another, it will not cease. In this sense, we and all around us are eternal, immortal, and profoundly connected. We don't have one soul; we have trillions upon trillions of them.

These are reasons enough for jubilation ... for riotous, unrestrained, exuberant merry-making.

So what are we missing?

Ceremony.

We lack ceremony. We lack ritual. We lack the initiation of baptism, the brotherhood of communal worship.

We have no loving ministers, guiding and teaching the flocks in the ways of the 'gods'. We have no fervent missionaries, no loyal apostles. And we lack the all-inclusive ecumenical embrace, the extended invitation to the unwashed masses. Alienation does not warm the heart;

communion does.

But what if? What if we appropriated the craft, the artistry, the methods of formal religion to get the message across? Imagine 'Einstein's Witnesses' going door to door or TV evangelists passionately espousing the beauty of evolution.

Imagine a Church of Latter Day Scientists where believers could gather. Imagine congregations raising their voices in tribute to gravity, the force that binds us all to the Earth, and the Earth to the Sun, and the Sun to the Milky Way. Or others rejoicing in the nuclear force that makes possible the sunlight of our star and the starlight of distant suns. And can't you just hear the hymns sung to the antiquity of the universe, its abiding laws, and the heaven above that 'we' will all one day inhabit, together, commingled, spread out like a nebula against a diamond sky?

One day, the sites we hold most sacred just might be the astronomical observatories, the particle accelerators, the university research installations, and other laboratories where the high priests of science — the biologists, the physicists, the astronomers, the chemists — engage in the noble pursuit of uncovering the workings of nature herself. And today's museums, expositional halls, and planetaria may then become tomorrow's houses of worship, where these revealed truths, and the wonder of our interconnectedness with the cosmos, are glorified in song by the devout and the soulful.

"Hallelujah!", they will sing. "May the force be with you!"

MICHAEL NESMITH
Artist, writer; Former cast member of "The Monkees"; A Trustee and President of the Gihon Foundation and a Trustee and Vice-Chair of the American Film Institute

Existence is Non-Time, Non-Sequential, and Non-Objective

Not a dangerous idea per se but like a razor sharp tool in unskilled hands it can inflect unintended damage.

Non-Time drives forward the notion the past does not create the present. This would of course render evolutionary theory a local-system, near-field process that was non-causative (i.e. effect).

Non-Sequential reverberates through the Turing machine and computation, and points to simultaneity. It redefines language and cognition.

Non-Objective establishes a continuum not to be confused with solipsism. As Schrödinger puts it when discussing the "time-hallowed discrimination between subject and object" — "the world is given to me only once, not one existing and one perceived. Subject and object are only one. The barrier between them cannot be said to have broken down as a result of recent experience in the physical sciences, for this barrier does not exist". This continuum has large implications for the empirical data set, as it introduces factual infinity into the data plane.

These three notions, Non-Time, Non-sequence, and Non-Object have been peeking like diamonds through the dust of empiricism, philosophy, and the sciences for centuries. Quantum mechanics, including Deutsch's parallel universes and the massive parallelism of quantum computing, is our brightest star — an unimaginably tall peak on our fitness landscape.

They bring us to a threshold over which empiricism has yet to travel, through which philosophy must reconstruct the very idea of ideas, and beyond which stretches the now familiar "uncharted territories" of all great adventures.

LAWRENCE KRAUSS
Physicist, Case Western Reserve University; Author, Atom

The world may fundamentally be inexplicable

Science has progressed for 400 years by ultimately explaining observed phenomena in terms of fundamental theories that are rigid. Even minor deviations from predicted behavior are not allowed by the theory, so that if such deviations are observed, these provide evidence that the theory must be modified, usually being replaced by a yet more comprehensive theory that fixes a wider range of phenomena.

The ultimate goal of physics, as it is often described, is to have a "theory of everything", in which all the fundamental laws that describe nature can neatly be written down on the front of a T-shirt (even if the T-shirt can only exist in 10 dimensions!). However, with the recognition that the dominant energy in the universe resides in empty space — something that is so peculiar that it appears very difficult to understand within the context of any theoretical ideas we now possess — more physicists have been exploring the idea that perhaps physics is an 'environmental science', that the laws of physics we observe are merely accidents of our circumstances, and that an infinite number of different universe could exist with different laws of physics.

This is true even if there does exist some fundamental candidate mathematical physical theory.

For example, as is currently in vogue in an idea related to string theory, perhaps the fundamental theory allows an infinite number of different 'ground state' solutions, each of which describes a different possible universe with a consistent set of physical laws and physical dimensions.

It might be that the only way to understand why the laws of nature we observe in our universe are the way they are is to understand that if they were any different, then life could not have arisen in our universe, and we would thus not be here to measure them today.

This is one version of the infamous "anthropic principle". But it could actually be worse — it is equally likely that many different combinations of laws would allow life to form, and that it is a pure accident that the constants of nature result in the combinations we experience in our universe. Or, it could be that the mathematical formalism is actually so complex so that the ground states of the theory, i.e. the set of possible states that might describe our universe, actually might not be determinable.

In this case, the end of "fundamental" theoretical physics (i.e. the search for fundamental microphysical laws...there will still be lots of work for physicists who try to understand the host of complex phenomena occurring at a variety of larger scales) might occur not via a theory of everything, but rather with the recognition that all so-called fundamental theories that might describe nature would be purely "phenomenological", that is, they would be derivable from observational phenomena, but would not reflect any underlying grand mathematical structure of the universe that would allow a basic understanding of why the universe is the way it is.

DANIEL C. DENNETT
Philosopher; University Professor, Co-Director, Center for Cognitive Studies, Tufts University; Author, Darwin's Dangerous Idea

There aren't enough minds to house the population explosion of memes

Ideas can be dangerous. Darwin had one, for instance. We hold all sorts of inventors and other innovators responsible for assaying, in advance, the *environmental impact* of their creations, and since ideas can have huge environmental impacts, I see no reason to exempt us thinkers from the responsibility of quarantining any deadly ideas we may happen to come across. So if I found what I took to be such a dangerous idea, I would button my lip until I could find some way of preparing the ground for its safe expression. I expect that others who are replying to this year's *Edge* question have engaged in similar reflections and arrived at the same policy. If so, then some people may be pulling their punches with their replies. The *really*

dangerous ideas they are keeping to themselves.

But here is an unsettling idea that is bound to be true in one version or another, and so far as I can see, it won't hurt to publicize it more. It might well help.

The human population is still growing, but at nowhere near the rate that the population of memes is growing. There is competition for the limited space in human brains for memes, and something has to give. Thanks to our incessant and often technically brilliant efforts, and our apparently insatiable appetites for novelty, we have created an explosively growing flood of information, in all media, on all topics, in every genre. Now either (1) we will drown in this flood of information, or (2) we won't drown in it. Both alternatives are deeply disturbing. What do I mean by drowning? I mean that we will become psychologically overwhelmed, unable to cope, victimized by the glut and unable to make life-enhancing decisions in the face of an unimaginable surfeit. (I recall the brilliant scene in the film of Evelyn Waugh's dark comedy *The Loved One* in which embalmer Mr. Joyboy's gluttonous mother is found sprawled on the kitchen floor, helplessly wallowing in the bounty that has spilled from a capsized refrigerator.) We will be lost in the maze, preyed upon by whatever clever forces find ways of pumping money–or simply further memetic replications–out of our situation. (In *The War of the Worlds*, H. G. Wells sees that it might well be our germs, not our high-tech military contraptions, that subdue our alien invaders. Similarly, might our own minds succumb not to the devious manipulations of evil brainwashers and propagandists, but to nothing more than a swarm of irresistible ditties, Nof s nibbled to death by slogans and one-liners?)

If we don't drown, how will we cope? If we somehow learn to swim in the rising tide of the infosphere, that will entail that we–that is to say, our grandchildren and their grandchildren–become very very different from our recent ancestors. What will "we" be like? (Some years ago, Doug Hofstadter wrote a wonderful piece, " In 2093, Just Who Will Be We?" in which he imagines robots being created to have "human" values, robots that gradually take over the social roles of our biological descendants, who become stupider and less concerned with the things *we* value. If we could secure the welfare of just one of these groups, our children or our brainchildren, which group would we care about the most, with which group would we identify?)

Whether "we" are mammals or robots in the not so distant future, what will we know and what will we have forgotten forever, as our previously shared intentional objects recede in the churning wake of the great ship that floats on this sea and charges into the future propelled by jets of newly packaged information? What will happen to our cultural landmarks? Presumably our descendants will all still recognize a few reference points (the pyramids of Egypt, arithmetic, the Bible, Paris, Shakespeare, Einstein, Bach . . .) but as wave after wave of novelty passes over them, what will they lose sight of? The Beatles are truly wonderful, but if their cultural immortality is to be purchased by the loss of such minor 20th century figures as Billie Holiday, Igor Stravinsky, and Georges Brassens [who he?], what will remain of our shared understanding?

The intergenerational mismatches that we all experience in macroscopic versions (great-grandpa's joke falls on deaf ears, because nobody else in the room knows that Nixon's wife was named "Pat") will presumably be multiplied to the point where much of the raw

information that we have piled in our digital storehouses is simply incomprehensible to everyone–except that we will have created phalanxes of "smart" Rosetta-stones of one sort or another that can "translate" the alien material into something we (think maybe we) understand. I suspect we hugely underestimate the importance (to our sense of cognitive security) of our regular participation in the four-dimensional human fabric of mutual understanding, with its reassuring moments of shared–and *seen* to be shared, and *seen* to be *seen* to be shared–comprehension.

What will happen to *common knowledge* in the future? I do think our ancestors had it easy: aside from all the juicy bits of unshared gossip and some proprietary trade secrets and the like, people all knew pretty much the same things, and knew that they knew the same things. There just wasn't that much to know. Won't people be able to create and exploit *illusions* of common knowledge in the future, virtual worlds in which people only think they are in touch with their cyber-neighbors?

I see small-scale projects that might protect us to some degree, if they are done wisely. Think of all the work published in academic journals before, say, 1990 that is in danger of becoming practically invisible to later researchers because it can't be found on-line with a good search engine. Just scanning it all and hence making it "available" is not the solution. There is too much of it. But we could start projects in which (virtual) communities of retired researchers who still have their wits about them and who know particular literatures well could brainstorm amongst themselves, using their pooled experience to elevate the forgotten gems, rendering them accessible to the next generation of researchers. This sort of activity has in the past been seen to be a stodgy sort of scholarship, fine for classicists and historians, but not fit work for cutting-edge scientists and the like. I think we should try to shift this imagery and help people recognize the importance of providing for each other this sort of pathfinding through the forests of information. It's a drop in the bucket, but perhaps if we all start thinking about conservation of valuable mind-space, we can save ourselves (our descendants) from informational collapse.

DANIEL GILBERT
Psychologist, Harvard University

The idea that ideas can be dangerous

Dangerous does not mean exciting or bold. It means likely to cause great harm. The most dangerous idea is the only dangerous idea: The idea that ideas can be dangerous.

We live in a world in which people are beheaded, imprisoned, demoted, and censured simply because they have opened their mouths, flapped their lips, and vibrated some air. Yes, those

vibrations can make us feel sad or stupid or alienated. Tough shit. That's the price of admission to the marketplace of ideas. Hateful, blasphemous, prejudiced, vulgar, rude, or ignorant remarks are the music of a free society, and the relentless patter of idiots is how we know we're in one. When all the words in our public conversation are fair, good, and true, it's time to make a run for the fence.

ANDY CLARK
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The quick-thinking zombies inside us

So much of what we do, feel, think and choose is determined by non-conscious, automatic uptake of cues and information.

Of course, advertisers will say they have known this all along. But only in recent years, with seminal studies by Tanya Chartrand, John Bargh and others has the true scale of our daily automatism really begun to emerge. Such studies show that it is possible (it is relatively easy) to activate racist stereotypes that impact our subsequent behavioral interactions, for example yielding the judgment that your partner in a subsequent game or task is more hostile than would be judged by an unprimed control. Such effects occur despite a subject's total and honest disavowal of those very stereotypes. In similar ways it is possible to unconsciously prime us to feel older (and then we walk more slowly).

In my favorite recent study, experimenters manipulate cues so that the subject forms an unconscious goal, whose (unnoticed) frustration makes them lose confidence and perform worse at a subsequent task! The dangerous truth, it seems to me, is that these are not isolated little laboratory events. Instead, they reveal the massed woven fabric of our day-to-day existence. The underlying mechanisms at work impart an automatic drive towards the automation of all manner of choices and actions, and don't discriminate between the 'trivial' and the portentous.

It now seems clear that many of my major life and work decisions are made very rapidly, often on the basis of ecologically sound but superficial cues, with slow deliberative reason busily engaged in justifying what the quick-thinking zombies inside me have already laid on the table. The good news is that without these mechanisms we'd be unable to engage in fluid daily life or reason at all, and that very often they are right. The dangerous truth, though, is that we are indeed designed to cut conscious, aware choice out of the picture wherever possible. This is not an issue about free will, but simply about the extent to which conscious deliberation cranks the engine of behavior. Crank it it does: but not in anything like the way, or extent, we may have thought. We'd better get to grips with this before someone else does.

SHERRY TURKLE

Psychologist, *MIT; Author,* Life on the Screen: Identity in the Age of the Internet

After several generations of living in the computer culture, simulation will become fully naturalized. Authenticity in the traditional sense loses its value, a vestige of another time.

Consider this moment from 2005: I take my fourteen-year-old daughter to the Darwin exhibit at the American Museum of Natural History. The exhibit documents Darwin's life and thought, and with a somewhat defensive tone (in light of current challenges to evolution by proponents of intelligent design), presents the theory of evolution as the central truth that underpins contemporary biology. The Darwin exhibit wants to convince and it wants to please. At the entrance to the exhibit is a turtle from the Galapagos Islands, a seminal object in the development of evolutionary theory. The turtle rests in its cage, utterly still. "They could have used a robot," comments my daughter. It was a shame to bring the turtle all this way and put it in a cage for a performance that draws so little on the turtle's "aliveness. " I am startled by her comments, both solicitous of the imprisoned turtle because it is alive and unconcerned by its authenticity. The museum has been advertising these turtles as wonders, curiosities, marvels — among the plastic models of life at the museum, here is the life that Darwin saw. I begin to talk with others at the exhibit, parents and children. It is Thanksgiving weekend. The line is long, the crowd frozen in place. My question, "Do you care that the turtle is alive?" is welcome diversion. A ten year old girl would prefer a robot turtle because aliveness comes with aesthetic inconvenience: "It's water looks dirty. Gross. " More usually, the votes for the robots echo my daughter's sentiment that in this setting, aliveness doesn't seem worth the trouble. A twelve-year-old girl opines: "For what the turtles do, you didn't have to have the live ones. " Her father looks at her, uncomprehending: "But the point is that they are real, that's the whole point. "

The Darwin exhibit is about authenticity: on display are the actual magnifying glass that Darwin used, the actual notebooks in which he recorded his observations, indeed, the very notebook in which he wrote the famous sentences that first described his theory of evolution But in the children's reactions to the inert but alive Galapagos turtle, the idea of the "original" is in crisis.

I have long believed that in the culture of simulation, the notion of authenticity is for us what sex was to the Victorians — "threat and obsession, taboo and fascination. " I have lived with this idea for many years, yet at the museum, I find the children's position startling, strangely unsettling. For these children, in this context, aliveness seems to have no intrinsic value. Rather, it is useful only if needed for a specific purpose. "If you put in a robot instead of the live turtle, do you think people should be told that the turtle is not alive?" I ask. Not really, say

several of the children. Data on "aliveness" can be shared on a "need to know" basis, for a purpose. But what *are* the purposes of living things? When do we need to know if something is alive?

Consider another vignette from 2005: an elderly woman in a nursing home outside of Boston is sad. Her son has broken off his relationship with her. Her nursing home is part of a study I am conducting on robotics for the elderly. I am recording her reactions as she sits with the robot Paro, a seal-like creature, advertised as the first "therapeutic robot" for its ostensibly positive effects on the ill, the elderly, and the emotionally troubled. Paro is able to make eye contact through sensing the direction of a human voice, is sensitive to touch, and has "states of mind" that are affected by how it is treated, for example, is it stroked gently or with agressivity? In this session with Paro, the woman, depressed because of her son's abandonment, comes to believe that the robot is depressed as well. She turns to Paro, strokes him and says: "Yes, you're sad, aren't you. It's tough out there. Yes, it's hard. " And then she pets the robot once again, attempting to provide it with comfort. And in so doing, she tries to comfort herself.

The woman's sense of being understood is based on the ability of computational objects like Paro to convince their users that they are in a relationship. I call these creatures (some virtual, some physical robots) "relational artifacts. " Their ability to inspire relationship is not based on their intelligence or consciousness, but on their ability to push certain "Darwinian" buttons in people (making eye contact, for example) that make people respond *as though* they were in relationship. For me, relational artifacts are the new uncanny in our computer culture — as Freud once put it, the long familiar taking a form that is strangely unfamiliar. As such, they confront us with new questions.

What does this deployment of "nurturing technology" at the two most dependent moments of the life cycle say about us? What will it do to us? Do plans to provide relational robots to attend to children and the elderly make us less likely to look for other solutions for their care? People come to feel love for their robots, but if our experience with relational artifacts is based on a fundamentally deceitful interchange, can it be good for us? Or might it be good for us in the "feel good" sense, but bad for us in our lives as moral beings?

Relationships with robots bring us back to Darwin and *his* dangerous idea: the challenge to human uniqueness. When we see children and the elderly exchanging tendernesses with robotic pets the most important question is not whether children will love their robotic pets more than their real life pets or even their parents, but rather, what will loving come to mean?

STEVEN STROGATZ
Applied mathematician, Cornell University; Author, *Sync*

The End of Insight

I worry that insight is becoming impossible, at least at the frontiers of mathematics. Even when we're able to figure out what's true or false, we're less and less able to understand why.

An argument along these lines was recently given by Brian Davies in the "Notices of the American Mathematical Society". He mentions, for example, that the four-color map theorem in topology was proven in 1976 with the help of computers, which exhaustively checked a huge but finite number of possibilities. No human mathematician could ever verify all the intermediate steps in this brutal proof, and even if someone claimed to, should we trust them? To this day, no one has come up with a more elegant, insightful proof. So we're left in the unsettling position of knowing that the four-color theorem is true but still not knowing why.

Similarly important but unsatisfying proofs have appeared in group theory (in the classification of finite simple groups, roughly akin to the periodic table for chemical elements) and in geometry (in the problem of how to pack spheres so that they fill space most efficiently, a puzzle that goes back to Kepler in the 1500's and that arises today in coding theory for telecommunications).

In my own field of complex systems theory, Stephen Wolfram has emphasized that there are simple computer programs, known as cellular automata, whose dynamics can be so inscrutable that there's no way to predict how they'll behave; the best you can do is simulate them on the computer, sit back, and watch how they unfold. Observation replaces insight. Mathematics becomes a spectator sport.

If this is happening in mathematics, the supposed pinnacle of human reasoning, it seems likely to afflict us in science too, first in physics and later in biology and the social sciences (where we're not even sure what's true, let alone why).

When the End of Insight comes, the nature of explanation in science will change forever. We'll be stuck in an age of authoritarianism, except it'll no longer be coming from politics or religious dogma, but from science itself.

TERRENCE SEJNOWSKI
Computational Neuroscientist, Howard Hughes Medical Institute; Coauthor, The Computational Brain

When will the Internet become aware of itself?

I never thought that I would become omniscient during my lifetime, but as Google continues to improve and online information continues to expand I have achieved omniscience for all practical purposes. The Internet has created a global marketplace for ideas and products, making it possible for individuals in the far corners of the world to automatically connect directly to each other. The Internet has achieved these capabilities by growing exponentially in total communications bandwidth. How does the communications power of the Internet compare with that of the cerebral cortex, the most interconnected part of our brains?

Cortical connections are expensive because they take up volume and cost energy to send information in the form of spikes along axons. About 44% of the cortical volume in humans is taken up with long-range connections, called the white matter. Interestingly, the thickness of gray matter, just a few millimeters, is nearly constant in mammals that range in brain volume over five orders of magnitude, and the volume of the white matter scales approximately as the 4/ 3 power of the volume of the gray matter. The larger the brain, the larger the fraction of resources devoted to communications compared to computation.

However, the global connectivity in the cerebral cortex is extremely sparse: The probability of any two cortical neurons having a direct connection is around one in a hundred for neurons in a vertical column 1 mm in diameter, but only one in a million for more distant neurons. Thus, only a small fraction of the computation that occurs locally can be reported to other areas, through a small fraction of the cells that connect distant cortical areas.

Despite the sparseness of cortical connectivity, the potential bandwidth of all of the neurons in the human cortex is approximately a terabit per second, comparable to the total world backbone capacity of the Internet. However, this capacity is never achieved by the brain in practice because only a fraction of cortical neurons have a high rate of firing at any given time. Recent work by Simon Laughlin suggests that another physical constraint — energy—limits the brain's ability to harness its potential bandwidth.

The cerebral cortex also has a massive amount of memory. There are approximately one billion synapses between neurons under every square millimeter of cortex, or about one hundred million million synapses overall. Assuming around a byte of storage capacity at each synapse (including dynamic as well as static properties), this comes to a total of 10^{15} bits of storage. This is comparable to the amount of data on the entire Internet; Google can store this in terabyte disk arrays and has hundreds of thousands of computers simultaneously sifting through it.

Thus, the internet and our ability to search it are within reach of the limits of the raw storage

and communications capacity of the human brain, and should exceed it by 2015.

Leo van Hemmen and I recently asked 23 neuroscientists to think about what we don't yet know about the brain, and to propose a question so fundamental and so difficult that it could take a century to solve, following in the tradition of Hilbert's 23 problems in mathematics. Christof Koch and Francis Crick speculated that the key to understanding consciousness was global communication: How do neurons in the diverse parts of the brain manage to coordinate despite the limited connectivity? Sometimes, the communication gets crossed, and V. S. Ramachandran and Edward Hubbard asked whether synesthetes, rare individuals who experience crossover in sensory perception such as hearing colors, seeing sounds, and tasting tactile sensations, might give us clues to how the brain evolved.

There is growing evidence that the flow of information between parts of the cortex is regulated by the degree of synchrony of the spikes within populations of cells that represent perceptual states. Robert Desimone and his colleagues have examined the effects of attention on cortical neurons in awake, behaving monkeys and found the coherence between the spikes of single neurons in the visual cortex and local field potentials in the gamma band, 30-80 Hz, increased when the covert attention of a monkey was directed toward a stimulus in the receptive field of the neuron. The coherence also selectively increased when a monkey searched for a target with a cued color or shape amidst a large number of distracters. The increase in coherence means that neurons representing the stimuli with the cued feature would have greater impact on target neurons, making them more salient.

The link between attention and spike-field coherence raises a number of interesting questions. How does top-down input from the prefrontal cortex regulate the coherence of neurons in other parts of the cortex through feedback connections? How is the rapidity of the shifts in coherence achieved? Experiments on neurons in cortical slices suggest that inhibitory interneurons are connected to each other in networks and are responsible for gamma oscillations. Researchers in my laboratory have used computational models to show that excitatory inputs can rapidly synchronize a subset of the inhibitory neurons that are in competition with other inhibitory networks. Inhibitory neurons, long thought to merely block activity, are highly effective in synchronizing neurons in a local column already firing in response to a stimulus.

The oscillatory activity that is thought to synchronize neurons in different parts of the cortex occurs in brief bursts, typically lasting for only a few hundred milliseconds. Thus, it is possible that there is a packet structure for long-distance communication in the cortex, similar to the packets that are used to communicate on the Internet, though with quite different protocols. The first electrical signals recorded from the brain in 1875 by Richard Caton were oscillatory signals that changed in amplitude and frequency with the state of alertness. The function of these oscillations remains a mystery, but it would be remarkable if it were to be discovered that these signals held the secrets to the brain's global communications network.

Since its inception in 1969, the Internet has been scaled up to a size not even imagined by its inventors, in contrast to most engineered systems, which fall apart when they are pushed beyond their design limits. In part, the Internet achieves this scalability because it has the ability to regulate itself, deciding on the best routes to send packets depending on traffic

conditions. Like the brain, the Internet has circadian rhythms that follow the sun as the planet rotates under it. The growth of the Internet over the last several decades more closely resembles biological evolution than engineering.

How would we know if the Internet were to become aware of itself? The problem is that we don't even know if some of our fellow creatures on this planet are self aware. For all we know the Internet is already aware of itself.

LYNN MARGULIS
Biologist, University of Massachusetts, Amherst; Coauthor (with Dorion Sagan), Acquiring Genomes: A Theory of the Origins of Species

Bacteria are us

What is my dangerous idea? Although arcane, evidence for this dangerous concept is overwhelming; I have collected clues from many sources. Reminiscent of Oscar Wilde's claim that "even true things can be proved" I predict that the scientific gatekeepers in academia eventually will be forced to permit this dangerous idea to become widely accepted. What is it?

Our sensibilities, our perceptions that register through our sense organ cells evolved directly from our bacterial ancestors. Signals in the environment: light impinging on the eye's retina, taste on the buds of the tongue, odor through the nose, sound in the ear are translated to nervous impulses by extensions of sensory cells called cilia. We, like all other mammals, including our apish brothers, have taste-bud cilia, inner ear cilia, nasal passage cilia that detect odors. We distinguish savory from sweet, birdsong from whalesong, drumbeats from thunder. With our eyes closed, we detect the light of the rising sun and and feel the vibrations of the drums. These abilities to sense our surroundings, a heritage that preceded the evolution of all primates, indeed, all animals, by use of specialized cilia at the tips of sensory cells, and the existence of the cilia in the tails of sperm, come from one kind of our bacterial ancestors. Which? Those of our bacterial ancestors that became cilia. We owe our sensitivity to a loving touch, the scent of lavender , the taste of a salted nut or vinaigrette, a police-cruiser siren, or glimpse of brilliant starlight to our sensory cells. We owe the chemical attraction of the sperm as its tail impels it to swim toward the egg, even the moss plant sperm, to its cilia. The dangerous idea is that the cilia evolved from hyperactive bacteria. Bacterial ancestors swam toward food and away from noxious gases, they moved up to the well-lit waters at the surface of the pond. They were startled when, in a crowd, some relative bumped them. These bacterial ancestors that never slept, avoided water too hot or too salty. They still do.

Why is the concept that our sensitivities evolved directly from swimming bacterial ancestors

of the sensory cilia so dangerous?

Several reasons: we would be forced to admit that bacteria are conscious, that they are sensitive to stimuli in their environment and behave accordingly. We would have to accept that bacteria, touted to be our enemies, are not merely neutral or friendly but that they are us. They are direct ancestors of our most sensitive body parts. Our culture's terminology about bacteria is that of warfare: they are germs to be destroyed and forever vanquished, bacterial enemies make toxins that poison us. We load our soaps with antibacterials that kill on contact, stomach ulcers are now agreed to be caused by bacterial infection. Even if some admit the existence of "good" bacteria in soil or probiotic food like yogurt few of us tolerate the dangerous notion that human sperm tails and sensitive cells of nasal passages lined with waving cilia, are former bacteria. If this dangerous idea becomes widespread it follows that we humans must agree that even before our evolution as animals we have hated and tried to kill our own ancestors. Again, we have seen the enemy, indeed, and, as usual, it is us. Social interactions of sensitive bacteria, then, not God, made us who were are today.

THOMAS METZINGER
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The Forbidden Fruit Intuition

We all would like to believe that, ultimately, intellectual honesty is not only an expression of, but also good for your mental health. My dangerous question is if one can be intellectually honest about the issue of free will and preserve one's mental health at the same time. Behind this question lies what I call the "Forbidden Fruit Intuition": Is there a set of questions which are dangerous not on grounds of ideology or political correctness, but because the most obvious answers to them could ultimately make our conscious self-models disintegrate? Can one *really* believe in determinism without going insane?

For middle-sized objects at 37° like the human brain and the human body, determinism is obviously true. The next state of the physical universe is always determined by the previous state. And given a certain brain-state plus an environment you could never have acted otherwise — a surprisingly large majority of experts in the free-will debate today accept this obvious fact. Although your future is open, this probably also means that for every single future thought you will have and for every single decision you will make, it is true that it was determined by your previous brain state.

As a scientifically well-informed person you believe in this theory, you endorse it. As an open-minded person you find that you are also interested in modern philosophy of mind, and you

might hear a story much like the following one. Yes, you are a physically determined system. But this is not a big problem, because, under certain conditions, we may still continue to say that you are "free": all that matters is that your actions are caused by the *right kinds* of brain processes and that they originate *in you*. A physically determined system can well be sensitive to reasons and to rational arguments, to moral considerations, to questions of value and ethics, as long as all of this is appropriately wired into its brain. You can be rational, and you can be moral, as long as your brain is physically determined in the *right* way. You like this basic idea: physical determinism is compatible with being a free agent. You endorse a materialist philosophy of freedom as well. An intellectually honest person open to empirical data, you simply believe that something along these lines must be true.

Now you try to *feel* that it is true. You try to consciously *experience* the fact that at any given moment of your life, you could not have acted otherwise. You try to experience the fact that even your thoughts, however rational and moral, are predetermined — by something unconscious, by something you can not see. And in doing so, you start fooling around with the conscious self-model Mother Nature evolved for you with so much care and precision over millions of years: You are scratching at the user-surface of your own brain, tweaking the mouse-pointer, introspectively trying to penetrate into the operating system, attempting to make the invisible visible. You are challenging the integrity of your phenomenal self by trying to integrate your new beliefs, the neuroscientific image of man, with your most intimate, inner way of experiencing yourself. How does it feel?

I think that the irritation and deep sense of resentment surrounding public debates on the freedom of the will actually has nothing much to do with the actual options on the table. It has to do with the — perfectly sensible — intuition that our presently obvious answer will not only be emotionally disturbing, but ultimately impossible to integrate into our conscious self-models.

Or our societies: The robust conscious experience of free will also is a social institution, because the attribution of accountability, responsibility, etc. are the decisive building blocks for modern, open societies. And the currently obvious answer might be interpreted by many as having clearly anti-democratic implications: Making a complex society work implies controlling the behavior of millions of people; if individual human beings can control their own behavior to a much lesser degree than we have thought in the past, if *bottom-up* doesn't work, then it becomes tempting to control it *top-down*, by the state. And this is the second way in which enlightenment could devour its own children. Yes, free will truly is a dangerous question, but for different reasons than most people think.

DIANE F. HALPERN

Professor of Psychology, Claremont McKenna College; Past-president (2005), the American Psychological Association; Author, Thought and Knowledge

Choosing the sex of one's child

For an idea to be truly dangerous, it needs to have a strong and near universal appeal. The idea of being able to choose the sex of one's own baby is just such an idea.

Anyone who has a deep-seated and profound preference for a son or daughter knows that this preference may not be rational and that it may represent a prejudice better left unacknowledged about them. It is easy to dismiss the ability to decide the sex of one's baby as inconsequential. It is already medically feasible for a woman or couple to choose the sex of a baby that has not yet been conceived. There are a variety of safe methods available, such as Preimplanted Genetic Diagnosis (PGD), so-named because it was originally designed for couples with fertility problems, not for the purpose of selecting the sex of one's next child. With PGD, embryos are created in a Petri dish, tested for gender, and then implanted into the womb, so that the baby-to-be is already identified as female or male before implantation in the womb. The pro argument is simple: If the parents-to-be are adults, why not? People have always wanted to be able to choose the sex of their children. There are ancient records of medicine men and wizened women with various herbs and assorted advice about what to do to (usually) have a son. So, what should it matter if modern medicine can finally deliver what old wives' tales have promised for countless generations? Couples won't have to have a "wasted" child, such as a second child the same sex as the first one, when they really wanted "one of each. " If a society has too many boys for a while, who cares? The shortage of females will make females more valuable and the market economy will even out in time. In the mean time, families will "balance out," each one the ideal composition as desired by the adults in the family.

Every year for the last two decades I have asked students in my college classes to write down the number of children they would like to have and the order in which they ideally want to have girls and boys. I have taught in several different countries (e.g. , Turkey, Russia, and Mexico) and types of universities, but despite large differences, the modal response is 2 children, first a boy, then a girl. If students reply that they want one child, it is most often a boy; if it is 3 children, they are most likely to want a boy, then a girl, then a boy. The students in my classes are not a random sample of the population: they are well educated and more likely to hold egalitarian attitudes than the general population. Yet, if they acted on their stated intentions, even they would have an excess of first-borns who are male, and an excess of males overall. In a short time, those personality characteristics associated with being either an only-child or first-born and those associated with being male would be so confounded, it would be difficult to separate them.

The excess of males that would result from allowing every mother or couple to choose the sex of their next baby would *not* correct itself at the societal level because at the individual level,

the preference for sons is stronger than the market forces of supply and demand. The evidence for this conclusion comes from many sources, including regions of the world where the ratio of young women to men is so low that it could only be caused by selective abortion and female infanticide (UNICEF and other sources). In some regions of rural China there are so few women that wives are imported from the Philippines and men move to far cities to find women to marry. In response, the Chinese government is now offering a variety of education and cash incentives to families with multiple daughters. There are still few daughters being born in these rural areas where prejudice against girls is stronger than government incentives and mandates. In India, the number of abortions of female fetuses has increased since sex-selective abortion was made illegal in 1994. The desire for sons is even stronger than the threat of legal action.

In the United States, the data that show preferences for sons are more subtle than the disparate ratios of females and males found in other parts of the world, but the preference for sons is still strong. Because of space limitations, I list only a few of the many indicators that parents in the United States prefer sons: families with 2 daughters are more likely to have a third child than families with 2 sons, unmarried pregnant women who undergo ultrasound to determine the sex of the yet unborn child are less likely to be married at the time of the child's birth when the child is a girl than when it is a boy, and divorced women with a son are more likely to remarry than divorced women with a daughter.

Perhaps the only ideas more dangerous that of choosing the sex of one's child would be trying to stop medical science from making advances that allow such choices or allowing the government to control the choices we can make as citizens. There are many important questions to ponder, including how to find creative ways to reduce or avoid negative consequences from even more dangerous alternatives. Consider, for example, what would our world be like if there were substantially more men than women? What if only the rich or only those who live in "rich countries" were able to choose the sex of their children? Is it likely that an approximately equal number of boys and girls would be or could be selected? If not, could a society or should a society make equal numbers of girls and boys a goal?

I am guessing that many readers of child-bearing age want to choose the sex of their (as yet) unconceived children and can reason that there is no harm in this practice. And, if you could also choose intelligence, height, and hair color, would you add that too? But then, there are few things in life that are as appealing as the possibility of a perfectly balanced family, which according to the modal response means an older son and younger daughter, looking just like an improved version of you.

GARY MARCUS
Psychologist, New York University; Author, The Birth of the Mind

Minds, genes, and machines

Brains exist primarily to do two things, to communicate (transfer information) and compute. This is true in every creature with a nervous system, and no less true in the human brain. In short, the brain is a machine. And the basic structure of that brain, biological substrate of all things mental, is guided in no small part by information carried in the DNA.

In the twenty-first century, these claims should no longer be controversial. With each passing day, techniques like magnetic resonance imaging and electrophysiological recordings from individual neurons make it clearer that the business of the brain is information processing, while new fields like comparative genomics and developmental neuroembryology remove any possible doubt that genes significantly influence both behavior and brain.

Yet there are many people, scientists and lay persons alike, who fear or wish to deny these notions, to doubt our even reject the idea that the mind is a machine, and that it is significantly (though of course not exclusively) shaped by genes. Even as the religious right prays for Intelligent Design, the academic left insinuates that merely discussing the idea of innateness is dangerous, as in a prominent child development manifesto that concluded:

If scientists use words like "instinct" and "innateness" in reference to human abilities, then we have a moral responsibility to be very clear and explicit about what we mean. If our careless, underspecified choice of words inadvertently does damage to future generations of children, we cannot turn with innocent outrage to the judge and say "But your Honor, I didn't realize the word was loaded.

A new academic journal called "Metascience" focuses on when extra-scientific considerations influence the process of science. Sadly, the twin questions of whether we are machines, and whether we are constrained significantly by our biology, very much fall into this category, questions where members of the academy (not to mention fans of Intelligent Design) close their minds.

Copernicus put us in our place, so to to speak, by showing that our planet is not at the center of universe; advances in biology are putting us further in our place by showing that our brains are as much a product of biology as any other part of our body, and by showing that our (human) brains are built by the very same processes as other creatures. Just as the earth is just one planet among many, from the perspective of the toolkit of developmental biology, our brain is just one more arrangement of molecules.

JARON LANIER
Computer Scientist and Musician

Homuncular Flexibility

The homunculus is an approximate mapping of the human body in the cortex. It is often visualized as a distorted human body stretched along the top of the human brain. The tongue, thumbs, and other body parts with extra-rich brain connections are enlarged in the homunculus, giving it a vaguely obscene, impish character.

Long ago, in the 1980s, my colleagues and I at VPL Research built virtual worlds in which more than one person at a time could be present. People in a shared virtual world must be able to see each other, as well as use their bodies together, as when two people lift a large virtual object or ride a tandem virtual bicycle. None of this would be possible without virtual bodies.

It was a self-evident and inviting challenge to attempt to create the most accurate possible bodies, given the crude state of the technology at the time. To do this, we developed full body suits covered in sensors. A measurement made on the body of someone wearing one of these suits, such as an aspect of the flex of a wrist, would be applied to control a corresponding change in a virtual body. Before long, people were dancing and otherwise goofing around in virtual reality.

Of course there were bugs. I distinctly remember a wonderful bug that caused my hand to become enormous, like a web of flying skyscrapers. As is often the case, this accident led to an interesting discovery.

It turned out that people could quickly learn to inhabit strange and different bodies and still interact with the virtual world. I became curious how weird the body could get before the mind would become disoriented. I played around with elongated limb segments, and strange limb placement. The most curious experiment involved a virtual lobster (which was lovingly modeled by Ann Lasko.) A lobster has a trio of little midriff arms on each side of its body. If physical human bodies sprouted corresponding limbs, we would have measured them with an appropriate body suit and that would have been that.

I assume it will not come as a surprise to the reader that the human body does not include these little arms, so the question arose of how to control them. The answer was to extract a little influence from each of many parts of the physical body and merge these data streams into a single control signal for a given joint in the extra lobster limbs. A touch of human elbow twist, a dash of human knee flex; a dozen such movements might be mixed to control the middle join of little left limb # 3. The result was that the principle elbows and knees could still control their virtual counterparts roughly as before, while still contributing to the control

of additional limbs.

Yes, it turns out people can learn to control bodies with extra limbs!

The biologist Jim Bower, when considering this phenomenon, commented that the human nervous system evolved through all the creatures that preceded us in our long evolutionary line, which included some pretty strange creatures, if you go back far enough. Why wouldn't we retain some homuncular flexibility with a pedigree like that?

The original experiments of the 1980s were not carried out formally, but recently it has become possible to explore the phenomenon in a far more rigorous way. Jeremy Bailenson at Stanford has created a marvelous new lab for studying multiple human subjects in high-definition shared virtual worlds, and we are now planning to repeat, improve, and extend these experiments. The most interesting questions still concern the limits to homuncular flexibility. We are only beginning the project of mapping how far it can go.

Why is homuncular flexibility a dangerous idea? Because the more flexible the human brain turns out to be when it comes to adapting to weirdness, the weirder a ride it will be able to keep up with as technology changes in the coming decades and centuries.

Will kids in the future grow up with the experience of living in four spatial dimensions as well as three? That would be a world with a fun elementary school math curriculum! If you're most interested in raw accumulation of technological power, then you might be not find this so interesting, but if you think in terms of how human experience can change, then this is the most fascinating stuff there is.

Homuncular flexibility isn't the only source of hints about how weird human experience might get in the future. There also questions related to language, memory, and other aspects of cognition, as well as hypothetical prospects for engineering changes in the brain. But in this one area, there's an indication of high weirdness to come, and I find that prospect dangerous, but in a beautiful and seductive way. "Thrilling" might be a better word.

W.DANIEL HILLIS
Physicist, Computer Scientist; Chairman, Applied Minds, Inc.; Author, The Pattern on the Stone

The idea that we should all share our most dangerous ideas

I don't share my most dangerous ideas. Ideas are the most powerful forces that we can unleash upon the world, and they should not be let loose without careful consideration of their consequences. Some ideas are dangerous because they are false, like an idea that one race

of humans is more worthy that another, or that one religion has monopoly on the truth. False ideas like these spread like wildfire, and have caused immeasurable harm. They still do. Such false ideas should obviously not be spread or encouraged, but there are also plenty of trues idea that should not be spread: ideas about how to cause terror and pain and chaos, ideas of how to better convince people of things that are not true.

I have often seen otherwise thoughtful people so caught up in such an idea that they seem unable to resist sharing it. To me, the idea that we should all share our most dangerous ideas is, itself, a very dangerous idea. I just hope that it never catches on.

NEIL GERSHENFELD
Physicist; Director, Center for Bits and Atoms, MIT; Author, Fab

Democratizing access to the means of invention

The elite temples of research (of the kind I've happily spent my career in) may be becoming intellectual dinosaurs as a result of the digitization and personalization of fabrication.

Today, with about $20k in equipment it's possible to make and measure things from microns and microseconds on up, and that boundary is quickly receding. When I came to MIT that was hard to do. If it's no longer necessary to go to MIT for its facilities, then surely the intellectual community is its real resource? But my colleagues (and I) are always either traveling or over-scheduled; the best way for us to see each other is to go somewhere else. Like many people, my closest collaborators are in fact distributed around the world.

The ultimate consequence of the digitization of first communications, then computation, and now fabrication, is to democratize access to the means of invention. The third world can skip over the first and second cultures and go right to developing a third culture. Rather than today's model of researchers researching for researchees, the result of all that discovery has been to enable a planet of creators rather than consumers.

PAUL STEINHARDT
Albert Einstein Professor of Science, Princeton University

It's a matter of time

For decades, the commonly held view among scientists has been that space and time first emerged about fourteen billion years ago in a big bang. According to this picture, the cosmos transformed from a nearly uniform gas of elementary particles to its current complex hierarchy of structure, ranging from quarks to galaxy superclusters, through an evolutionary process governed by simple, universal physical laws. In the past few years, though, confidence in this point of view has been shaken as physicists have discovered finely tuned features of our universe that seem to defy natural explanation.

The prime culprit is the cosmological constant, which astronomers have measured to be exponentially smaller than naïve estimates would predict. On the one hand, it is crucial that the cosmological constant be so small or else it would cause space to expand so rapidly that galaxies and stars would never form. On the other hand, no theoretical mechanism has been found within the standard Big Bang picture that would explain the tiny value.

Desperation has led to a "dangerous" idea: perhaps we live in an anthropically selected universe. According to this view, we live in a multiverse (a multitude of universes) in which the cosmological constant varies randomly from one universe to the next. In most universes, the value is incompatible with the formation of galaxies, planets, and stars. The reason why our cosmological constant has the value it does is because it it is one of the rare examples in which the value happens to lie in the narrow range compatible with life.

This is the ultimate example of "unintelligent design": the multiverse tries every possibility with reckless abandon and only very rarely gets things "right;" that is, consistent with everything we actually observe. It suggests that the creation of unimaginably enormous volumes of uninhabitable space is essential to obtain a few rare habitable spaces.

I consider this approach to be extremely dangerous for two reasons. First, it relies on complex assumptions about physical conditions far beyond the range of conceivable observation so it is not scientifically verifiable. Secondly, I think it leads inevitably to a depressing end to science. What is the point of exploring further the randomly chosen physical properties in our tiny corner of the multiverse if most of the multiverse is so different. I think it is far too early to be so desperate. This is a dangerous idea that I am simply unwilling to contemplate.

My own "dangerous" idea is more optimistic but precarious because it bucks the current trends in cosmological thinking. I believe that the finely tuned features may be naturally explained by supposing that our universe is much older than we have imagined. With more time, a new possibility emerges. The cosmological "constant" may not be constant after all. Perhaps it is varying so slowly that it only appears to be constant. Originally it had the much larger value that we would naturally estimate, but the universe is so old that its value has had a chance to relax to the tiny value measured today. Furthermore, in several concrete examples, one finds that the evolution of the cosmological constant slows down as its value approaches zero, so most of the history of the universe transpires when its value is tiny, just as we find today.

This idea that the cosmological constant is decreasing has been considered in the past. In fact, physically plausible slow-relaxation mechanisms have been identified. But the timing was thought to be impossible. If the cosmological constant decreases very slowly, it causes the expansion rate to accelerate too early and galaxies never form. If it decreases too quickly, the expansion rate never accelerates, which is inconsistent with recent observations. As long as the cosmological constant has only 14 billion years to evolve, there is no feasible solution.

But, recently, some cosmologists have been exploring the possibility that the universe is exponentially older. In this picture, the evolution of the universe is cyclic. The Big Bang is not the beginning of space and time but, rather, a sudden creation of hot matter and radiation that marks the transition from one period of expansion and cooling to the next cycle of evolution. Each cycle might last a trillion years, say. Fourteen billion years marks the time since the last infusion of matter and radiation, but this is brief compared to the total age of the universe. Each cycle lasts about a trillion years and the number of cycles in the past may have been ten to the googol power or more!

Then, using the slow relaxation mechanisms considered previously, it becomes possible that the cosmological constant decreases steadily from one cycle to the next. Since the number of cycles is likely to be enormous, there is enough time for the cosmological constant to shrink by an exponential factor, even though the decrease over the course of any one cycle is too small to be undetectable. Because the evolution slows down as the cosmological constant decreases, this is the period when most of the cycles take place. There is no multiverse and there is nothing special about our region of space — we live in a typical region at a typical time.

Remarkably, this idea is scientifically testable. The picture makes explicit predictions about the distribution of primordial gravitational waves and variations in temperature and density. Also, if the cosmological constant is evolving at the slow rate suggested, then ongoing attempts to detect a temporal variation should find no change. So, we may enjoy speculating now about which dangerous ideas we prefer, but ultimately it is Nature that will decide if any of them is right. It is just a matter of time.

SAM HARRIS
Neuroscience Graduate Student, UCLA; Author, The End of Faith

Science Must Destroy Religion

Most people believe that the Creator of the universe wrote (or dictated) one of their books. Unfortunately, there are many books that pretend to divine authorship, and each makes incompatible claims about how we all must live. Despite the ecumenical efforts of many well-

intentioned people, these irreconcilable religious commitments still inspire an appalling amount of human conflict.

In response to this situation, most sensible people advocate something called "religious tolerance." While religious tolerance is surely better than religious war, tolerance is not without its liabilities. Our fear of provoking religious hatred has rendered us incapable of criticizing ideas that are now patently absurd and increasingly maladaptive. It has also obliged us to lie to ourselves — repeatedly and at the highest levels — about the compatibility between religious faith and scientific rationality.

The conflict between religion and science is inherent and (very nearly) zero-sum. The success of science often comes at the expense of religious dogma; the maintenance of religious dogma always comes at the expense of science. It is time we conceded a basic fact of human discourse: either a person has good reasons for what he believes, or he does not. When a person has good reasons, his beliefs contribute to our growing understanding of the world. We need not distinguish between "hard" and "soft" science here, or between science and other evidence-based disciplines like history. There happen to be very good reasons to believe that the Japanese bombed Pearl Harbor on December 7th, 1941. Consequently, the idea that the Egyptians actually did it lacks credibility. Every sane human being recognizes that to rely merely upon "faith" to decide specific questions of historical fact would be both idiotic and grotesque — that is, until the conversation turns to the origin of books like the bible and the Koran, to the resurrection of Jesus, to Muhammad's conversation with the angel Gabriel, or to any of the other hallowed travesties that still crowd the altar of human ignorance.

Science, in the broadest sense, includes all reasonable claims to knowledge about ourselves and the world. If there were good reasons to believe that Jesus was born of a virgin, or that Muhammad flew to heaven on a winged horse, these beliefs would necessarily form part of our rational description of the universe. Faith is nothing more than the license that religious people give one another to believe such propositions when reasons fail. The difference between science and religion is the difference between a willingness to dispassionately consider new evidence and new arguments, and a passionate unwillingness to do so. The distinction could not be more obvious, or more consequential, and yet it is everywhere elided, even in the ivory tower.

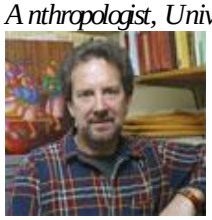
Religion is fast growing incompatible with the emergence of a global, civil society. Religious faith — faith that there is a God who cares what name he is called, that one of our books is infallible, that Jesus is coming back to earth to judge the living and the dead, that Muslim martyrs go straight to Paradise, etc. — is on the wrong side of an escalating war of ideas. The difference between science and religion is the difference between a genuine openness to fruits of human inquiry in the 21st century, and a premature closure to such inquiry as a matter of principle. I believe that the antagonism between reason and faith will only grow more pervasive and intractable in the coming years. Iron Age beliefs — about God, the soul, sin, free will, etc. — continue to impede medical research and distort public policy. The possibility that we could elect a U.S. President who takes biblical prophesy seriously is real and terrifying; the likelihood that we will one day confront Islamists armed with nuclear or biological weapons is also terrifying, and growing more probable by the day. We are doing very little, at the level of our intellectual discourse, to prevent such possibilities.

In the spirit of religious tolerance, most scientists are keeping silent when they should be blasting the hideous fantasies of a prior age with all the facts at their disposal.

To win this war of ideas, scientists and other rational people will need to find new ways of talking about ethics and spiritual experience. The distinction between science and religion is not a matter of excluding our ethical intuitions and non-ordinary states of consciousness from our conversation about the world; it is a matter of our being rigorous about what is reasonable to conclude on their basis. We must find ways of meeting our emotional needs that do not require the abject embrace of the preposterous. We must learn to invoke the power of ritual and to mark those transitions in every human life that demand profundity — birth, marriage, death, etc. — without lying to ourselves about the nature of reality.

I am hopeful that the necessary transformation in our thinking will come about as our scientific understanding of ourselves matures. When we find reliable ways to make human beings more loving, less fearful, and genuinely enraptured by the fact of our appearance in the cosmos, we will have no need for divisive religious myths. Only then will the practice of raising our children to believe that they are Christian, Jewish, Muslim, or Hindu be broadly recognized as the ludicrous obscenity that it is. And only then will we stand a chance of healing the deepest and most dangerous fractures in our world.

SCOTT ATRAN
Anthropologist, University of Michigan; Author, In God's We Trust



Science encourages religion in the long run (and vice versa)

Ever since Edward Gibbon's *Decline and Fall of the Roman Empire*, scientists and secularly-minded scholars have been predicting the ultimate demise of religion. But, if anything, religious fervor is increasing across the world, including in the United States, the world's most economically powerful and scientifically advanced society. An underlying reason is that science treats humans and intentions only as incidental elements in the universe, whereas for religion they are central. Science is not particularly well-suited to deal with people's existential anxieties, including death, deception, sudden catastrophe, loneliness or longing for love or justice. It cannot tell us what we ought to do, only what we can do. Religion thrives because it addresses people's deepest emotional yearnings and society's foundational moral needs, perhaps even more so in complex and mobile societies that are increasingly divorced from nurturing family settings and long familiar environments.

From a scientific perspective of the overall structure and design of the physical universe:

1. Human beings are accidental and incidental products of the material development of the universe, almost wholly irrelevant and readily ignored in any general description of its functioning.

Beyond Earth, there is no intelligence — however alien or like our own — that is watching out for us or cares. We are alone.

2. Human intelligence and reason, which searches for the hidden traps and causes in our surroundings, evolved and will always remain leashed to our animal passions — in the struggle for survival, the quest for love, the yearning for social standing and belonging.

This intelligence does not easily suffer loneliness, anymore than it abides the looming prospect of death, whether individual or collective.

Religion is the hope that science is missing (something more in the endeavor to miss nothing).

But doesn't religion impede science, and vice versa? Not necessarily. Leaving aside the sociopolitical stakes in the opposition between science and religion (which vary widely are not constitutive of science or religion per se — Calvin considered obedience to tyrants as exhibiting trust in God, Franklin wanted the motto of the American Republic to be "rebellion against tyranny is obedience to God"), a crucial difference between science and religion is that factual knowledge as such is not a principal aim of religious devotion, but plays only a supporting role. Only in the last decade has the Catholic Church reluctantly acknowledged the factual plausibility of Copernicus, Galileo and Darwin. Earlier religious rejection of their theories stemmed from challenges posed to a cosmic order unifying the moral and material worlds. Separating out the core of the material world would be like draining the pond where a water lily grows. A long lag time was necessary to refurbish and remake the moral and material connections in such a way that would permit faith in a unified cosmology to survive.

MARCELO GLEISER
Physicist, Dartmouth College; Author, The Prophet and the Astronome

Can science explain itself?

There have been many times when I asked myself if we scientists, especially those seeking to answer "ultimate" kind of questions such as the origin of the Universe, are not beating on the wrong drum. Of course, by trying to answer such question as the origin of everything, we assume we can. We plow ahead, proposing tentative models that join general relativity and quantum mechanics and use knowledge from high energy physics to propose models where the universe pops out of nothing, no energy required, due to a random quantum fluctuation.

To this, we tag along the randomness of fundamental constants, saying that their values are the way they are due to an accident: other universes may well have other values of the charge and mass of the electron and thus completely different properties. So, our universe becomes this very special place where things "conspire" to produce galaxies, stars, planets, and life.

What if this is all bogus? What if we look at sciece as a narrative, a description of the world that has limitations based on its structure? The constants of Nature are the letters of the alphabet, the laws are the grammar rules and we build these descriptions through the guiding hand of the so-called scientific method. Period. To say things are this way because otherwise we wouldn't be here to ask the question is to miss the point altogether: things are this way because this is the story we humans tell based on the way we see the world and explain it.

If we take this to the extreme, it means that we will never be able to answer the question of the origin of the Universe, since it implicitly assumes that science can explain itself. We can build any cool and creative models we want using any marriage of quantum mechanics and relativity, but we still won't understand why these laws and not others. In sense, this means that our science is our science and not something universally true as many believe it is. This is not bad at all, given what we can do with it, but it does place limits on knowledge. Which may also not be a bad thing as well. It's OK not to know everything, it doesn't make science weaker. Only more human.

DOUGLAS RUSHKOFF
Media Analyst; Documentary Writer; Author, Get Back in the Box : Innovation from the Inside Out

Open Source Currency

It's not only dangerous and by most counts preposterous; it's happening. Open Source or, in more common parlance, "complementary" currencies are collaboratively established units representing hours of labor that can be traded for goods or services in lieu of centralized currency. The advantage is that while the value of centralized currency is based on its scarcity, the bias of complementary or local currencies is towards their abundance.

So instead of having to involve the Fed in every transaction — and using money that requires being paid back with interest — we can invent our own currencies and create value with our labor. It's what the Japanese did at the height of the recession. No, not the Japanese government, but unemployed Japanese people who couldn't afford to pay healthcare costs for their elder relatives in distant cities. They created a currency through which people could care for someone else's grandmother, and accrue credits for someone else to take care of theirs.

Throughout most of history, complementary currencies existed alongside centralized currency. While local currency was used for labor and local transactions, centralized currencies were used for long distance and foreign trade. Local currencies were based on a model of abundance — there was so much of it that people constantly invested it. That's why we saw so many cathedrals being built in the late middle ages, and unparalleled levels of investment in infrastructure and maintenance. Centralized currency, on the other hand, needed to retain value over long distances and periods of time, so it was based on precious and scarce resources, such as gold.

The problem started during the Renaissance: as kings attempted to centralize their power, most local currencies were outlawed. This new monopoly on currency reduced entire economies into scarcity engines, encouraging competition over collaboration, protectionism over sharing, and fixed commodities over renewable resources. Today, money is lent into existence by the Fed or another central bank — and paid back with interest.

This cash is a medium; and like any medium, it has certain biases. The money we use today is just one model of money. Turning currency into an collaborative phenomenon is the final frontier in the open source movement. It's what would allow for an economic model that could support a renewable energies industry, a way for companies such as Wal-Mart to add value to the communities it currently drains, and a way of working with money that doesn't have bankruptcy built in as a given circumstanc

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JUDITH RICH HARRIS
Independent Investigator and Theoretician; Author, The Nurture Assumption

The idea of zero parental influence

Is it dangerous to claim that parents have no power at all (other than genetic) to shape their child's personality, intelligence, or the way he or she behaves outside the family home? More to the point, is this claim false? Was I wrong when I proposed that parents' power to do these things by environmental means is zero, nada, zilch?

A confession: When I first made this proposal ten years ago, I didn't fully believe it myself. I took an extreme position, the null hypothesis of zero parental influence, for the sake of scientific clarity. Making myself an easy target, I invited the establishment — research psychologists in the academic world — to shoot me down. I didn't think it would be all that difficult for them to do so. It was clear by then that there weren't any big effects of parenting, but I thought there must be modest effects that I would ultimately have to acknowledge.

The establishment's failure to shoot me down has been nothing short of astonishing. One

developmental psychologist even admitted, one year ago on this very website, that researchers hadn't yet found proof that "parents do shape their children," but she was still convinced that they will eventually find it, if they just keep searching long enough.

Her comrades in arms have been less forthright. "There are *dozens* of studies that show the influence of parents on children!" they kept saying, but then they'd somehow forget to name them — perhaps because these studies were among the ones I had already demolished (by showing that they lacked the necessary controls or the proper statistical analyses). Or they'd claim to have newer research that provided an airtight case for parental influence, but again there was a catch: the work had never been published in a peer-reviewed journal. When I investigated, I could find no evidence that the research in question had actually been done or, if done, that it had produced the results that were claimed for it. At most, it appeared to consist of preliminary work, with too little data to be meaningful (or publishable).

Vaporware, I call it. Some of the vaporware has achieved mythic status. You may have heard of Stephen Suomi's experiment with nervous baby monkeys, supposedly showing that those reared by "nurturant" adoptive monkey mothers turn into calm, socially confident adults. Or of Jerome Kagan's research with nervous baby humans, supposedly showing that those reared by "overprotective" (that is, nurturant) human mothers are more likely to remain fearful.

Researchers like these might well see my ideas as dangerous. But is the notion of zero parental influence dangerous in any other sense? So it is alleged. Here's what Frank Farley, former president of the American Psychological Association, told a journalist in 1998:

[Harris's] thesis is absurd on its face, but consider what might happen if parents believe this stuff! Will it free some to mistreat their kids, since "it doesn't matter"? Will it tell parents who are tired after a long day that they needn't bother even paying any attention to their kid since "it doesn't matter"?

Farley seems to be saying that the only reason parents are nice to their children is because they think it will make the children turn out better! And that if parents believed that they had no influence at all on how their kids turn out, they are likely to abuse or neglect them.

Which, it seems to me, is absurd on its face. Most chimpanzee mothers are nice to their babies and take good care of them. Do chimpanzees think they're going to influence how their offspring turn out? Doesn't Frank Farley know anything at all about evolutionary biology and evolutionary psychology?

My idea is viewed as dangerous by the powers that be, but I don't think it's dangerous at all. On the contrary: if people accepted it, it would be a breath of fresh air. Family life, for parents and children alike, would improve. Look what's happening now as a result of the faith, obligatory in our culture, in the power of parents to mold their children's fragile psyches. Parents are exhausting themselves in their efforts to meet their children's every demand, not realizing that evolution designed offspring — nonhuman animals as well as humans — to demand more than they really need. Family life has become phony, because parents are convinced that children need constant reassurances of their love, so if they don't happen to feel very loving at a particular time or towards a particular child, they fake it. Praise is delivered

by the bushel, which devalues its worth. Children have become the masters of the home.

And what has all this sacrifice and effort on the part of parents bought them? Zilch. There are no indications that children today are happier, more self-confident, less aggressive, or in better mental health than they were sixty years ago, when I was a child — when homes were run by and for adults, when physical punishment was used routinely, when fathers were generally unavailable, when praise was a rare and precious commodity, and when explicit expressions of parental love were reserved for the deathbed.

Is my idea dangerous? I've never condoned child abuse or neglect; I've never believed that parents don't matter. The relationship between a parent and a child is an important one, but it's important in the same way as the relationship between married partners. A good relationship is one in which each party cares about the other and derives happiness from making the other happy. A good relationship is not one in which one party's central goal is to modify the other's personality.

I think what's really dangerous — perhaps a better word is tragic — is the establishment's idea of the all-powerful, and hence all-blamable, parent.

ALUN ANDERSON
Senior Consultant, New Scientist

Brains cannot become minds without bodies

A common image for popular accounts of the "The Mind" is a brain in a bell jar. The message is that inside that disembodied lump of neural tissue is everything that is you.

It's a scary image but misleading. A far more dangerous idea is that brains cannot become minds without bodies, that two-way interactions between mind and body are crucial to thought and health, and the brain may partly think in terms of the motor actions it encodes for the body's muscles to carry out.

We've probable fallen for disembodied brains because of the academic tendency to worship abstract thought. If we take a more democratic view of the whole brain we'd find far more of it being used for planning and controlling movement than for cogitation. Sports writers get it right when they describe stars of football or baseball as "geniuses"! Their genius requires massive brain power and a superb body, which is perhaps one better than Einstein.

The "brain-body" view is dangerous because it requires many scientists to change the way they think: it allows back common sense interactions between brain and body that medical science

feels uncomfortable with, makes more sense of feelings like falling in love and requires a different approach for people who are trying to create machines with human-like intelligence. And if this all sounds like mere assertion, there's plenty of interesting research out there to back it up.

Interactions between mind and body come out strongly in the surprising links between status and health. Michael Marmot's celebrated studies show that the lower you are in the pecking order, the worse your health is likely to be. You can explain away only a small part of the trend from poorer access to healthcare, or poorer food or living conditions. For Marmot, the answer lies in "the impact over how much control you have over life circumstances". The important message is that state of mind — perceived status — translates into state of body.

The effect of placebos on health delivers a similar message. Trust and belief are often seen as negative in science and the placebo effect is dismissed as a kind of "fraud" because it relies on the belief of the patient. But the real wonder is that faith can work. Placebos can stimulate the release of pain-relieving endorphins and affect neuronal firing rates in people with Parkinson's disease.

Body and mind interact too in the most intimate feelings of love and bonding. Those interactions have been best explored in voles where two hormones, oxytocin and vasopressin, are critical. The hormones are released as a result of the "the extended tactile pleasures of mating", as researchers describe it, and hit pleasure centres in the brain which essentially "addict" sexual partners to one another.

Humans are surely more cerebral. But brain scans of people in love show heightened activity where there are lots of oxytocin and vasopressin receptors. Oxytocin levels rise during orgasm and sexual arousal, as they do from touching and massage. There are defects in oxytocin receptors associated with autism. And the hormone boosts the feeling that you can trust others, which is key part of intimate relations. In a recent laboratory "investment game" many investors would trust all their money to a stranger after a puff of an oxytocin spray.

These few stories show the importance of the interplay of minds and hormonal signals, of brains and bodies. This idea has been taken to a profound level in the well-known studies of Anthony Damasio, who finds that emotional or "gut feelings" are essential to making decisions. "We don't separate emotion from cognition like layers in a cake," says Damasio, "Emotion is in the loop of reason all the time."

Indeed, the way in which reasoning is tied to body actions may be quite counter-intuitive. Giacomo Rizzolatti discovered "mirror neurones" in a part of the monkey brain responsible for planning movement. These nerve cells fire both when a monkey performs an action (like picking up a peanut) and when the monkey sees someone else do the same thing. Before long, similar systems were found in human brains too.

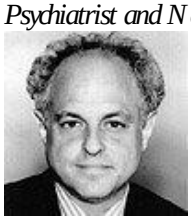
The surprising conclusion may be that when we see someone do something, the same parts of our brain are activated "as if" we were doing it ourselves. We may know what other people intend and feel by simulating what they are doing within the same motor areas of our own

brains.

As Rizzolatti puts it, "the fundamental mechanism that allows us a direct grasp of the mind of others is not conceptual reasoning but direct simulation of the observed events through the mirror mechanism." Direct grasp of others' minds is a special ability that paves the way for our unique powers of imitation which in turn have allowed culture to develop.

If bodies and their interaction with brain and planning for action in the world are so central to human kinds of mind, where does that leave the chances of creating an intelligent "disembodied mind" inside a computer? Perhaps the Turing test will be harder than we think. We may build computers that understand language but which cannot say anything meaningful, at least until we can give them "extended tactile experiences". To put it another way, computers may not be able to make sense until they can have sex.

TODD E. FEINBERG, M.D.
Psychiatrist and Neurologist, Albert Einstein College of Medicine; Author, Altered Egos



Myths and fairy tales are not true

"Myths and fairy tales are not true." There is no Easter Bunny, there is no Santa Claus, and Moses may never have existed. Worse yet, I have increasing difficulty believing that there is a higher power ruling the universe. This is my dangerous idea. It is not a dangerous idea to those who do not share my particular world view or personal fears; to others it may seem trivially true. But for me, this idea is downright horrifying.

I came to ponder this idea through my neurological examination of patients with brain damage that causes a disturbance in their self concepts and ego functions.

Some of theses patients develop, in the course of their illness and recovery (or otherwise), disturbances of self and personal relatedness that create enduring delusions and metaphorical confabulations regarding their bodies, their relationships with loved ones, and their personal experiences. A patient I examined with a right hemisphere stroke and paralyzed left arm claimed that the arm was actually severed from his brother's body by gang members, thrown in the East river, and later attached to the patient's shoulder. Another patient with a ruptured brain aneurysm and amnesia who denied his disabilities claimed he was planning to adopt (a phantom) child who was in need of medical assistance.

These personal narratives, produced by patients in altered neurological states and therefore without the constraints imposed by a fully functioning consciousness, have a dream-like quality, and constitute "personal myths" that express the patient's beliefs about themselves.

The patient creates a metaphor in which personal experiences are crystallized in a metaphor in the form of an external real or fictitious persons, objects, places, or events. When this occurs, the metaphor serves as a symbolic representation or externalization of the patient's feelings that the patient does not realize originate from within the self.

There is an intimate relationship between my patients' narratives and socially endorsed fairy tales and mythologies. This is particularly apparent when mythologies deal with themes relating to a loss of self, personal identity or death. For many people, the notion of personal death is extremely difficult to grasp and fully accommodate within one's self image. For many, in order to go on with life, death must be denied. Therefore, to help the individual deal with the prospect of the inevitability of personal death, cultural and religious institutions provide metaphors of everlasting life. Just as my patients adapt to difficult realities by creating metaphorical substitutes, it appears to me that beliefs in angels, deities and eternal souls can be understood in part as wish fulfilling metaphors for an unpleasant reality that most of us cannot fully comprehend and accept.

Unfortunately, just as my patients' myths are not true, neither are those that I was brought up to believe in.

STEWART BRAND

Founder, Whole Earth Catalog, *cofounder; The Well; cofounder, Global Business Network; Author,* How Buildings Learn

What if public policy makers have an obligation to engage historians, and historians have an obligation to try to help?

All historians understand that they must never, ever talk about the future. Their discipline requires that they deal in facts, and the future doesn't have any yet. A solid theory of history might be able to embrace the future, but all such theories have been discredited. Thus historians do not offer, and are seldom invited, to take part in shaping public policy. They leave that to economists.

But discussions among policy makers always invoke history anyway, usually in simplistic form. "Munich" and "Vietnam," devoid of detail or nuance, stand for certain kinds of failure. "Marshall Plan" and "Man on the Moon" stand for certain kinds of success. Such totemic invocation of history is the opposite of learning from history, and Santayana's warning continues in force, that those who fail to learn from history are condemned to repeat it.

A dangerous thought: What if public policy makers have an obligation to engage historians,

and historians have an obligation to try to help?

And instead of just retailing advice, go generic. Historians could set about developing a rigorous sub-discipline called "Applied History."

There is only one significant book on the subject, published in 1988. *Thinking In Time: The Uses of History for Decision Makers* was written by the late Richard Neustadt and Ernest May, who long taught a course on the subject at Harvard's Kennedy School of Government. (A course called "Reasoning from History" is currently taught there by Alexander Keyssar.)

Done wrong, Applied History could paralyze public decision making and corrupt the practice of history — that's the danger. But done right, Applied History could make decision making and policy far more sophisticated and adaptive, and it could invest the study of history with the level of consequence it deserves.

JARED DIAMOND
Biologist; Geographer, UCLA; Author, Collapse

The evidence that tribal peoples often damage their environments and make war.

Why is this idea dangerous? Because too many people today believe that a reason not to mistreat tribal people is that they are too nice or wise or peaceful to do those evil things, which only we evil citizens of state governments do. The idea is dangerous because, if you believe that that's the reason not to mistreat tribal peoples, then proof of the idea's truth would suggest that it's OK to mistreat them. In fact, the evidence seems to me overwhelming that the dangerous idea is true. But we should treat other people well because of ethical reasons, not because of naïve anthropological theories that will almost surely prove false.

LEONARD SUSSKIND
Physicist, Stanford University; Author, *The Cosmic Landscape*

The "Landscape"

I have been accused of advocating an extremely dangerous idea.

According to some people, the "Landscape" idea will eventually ensure that the forces of intelligent design (and other unscientific religious ideas) will triumph over true science. From one of my most distinguished colleagues:

From a political, cultural point of view, it's not that these arguments are religious but that they denude us from our historical strength in opposing religion.

Others have expressed the fear that my ideas, and those of my friends, will lead to the end of science (methinks they overestimate me). One physicist calls it "millennial madness."

And from another quarter, Christoph Schönborn, Cardinal Archbishop of Vienna has accused me of "an abdication of human intelligence."

As you may have guessed the idea in question is the Anthropic Principle: a principle that seeks to explain the laws of physics, and the constants of nature, by saying, "If they (the laws of physics) were different, intelligent life would not exist to ask why laws of nature are what they are."

On the face of it, the Anthropic Principle is far too silly to be dangerous. It sounds no more sensible than explaining the evolution of the eye by saying that unless the eye evolved, there would be no one to read this page. But the A.P. is really shorthand for a rich set of ideas that are beginning to influence and even dominate the thinking of almost all serious theoretical physicists and cosmologists.

Let me strip the idea down to its essentials. Without all the philosophical baggage, what it says is straightforward: The universe is vastly bigger than the portion that we can see; and, on a very large scale it is as varied as possible. In other words, rather than being a homogeneous, mono-colored blanket, it is a crazy-quilt patchwork of different environments. This is not an idle speculation. There is a growing body of empirical evidence confirming the inflationary theory of cosmology, which underlies the hugeness and hypothetical diversity of the universe.

Meanwhile string theorists, much to the regret of many of them, are discovering that the number of possible environments described by their equations is far beyond millions or billions. This enormous space of possibilities, whose multiplicity may exceed ten to the 500 power, is called the Landscape. If these things prove to be true, then some features of the laws of physics (maybe most) will be local environmental facts rather than written-in-stone laws: laws that could not be otherwise. The explanation of some numerical coincidences will necessarily be that most of the multiverse is uninhabitable, but in some very tiny fraction conditions are fine-tuned enough for intelligent life to form.

That's the dangerous idea and it is spreading like a cancer.

Why is it that so many physicists find these ideas alarming? Well, they *do* threaten physicists' fondest hope, the hope that some extraordinarily beautiful mathematical principle will be

discovered: a principle that would completely and uniquely explain every detail of the laws of particle physics (and therefore nuclear, atomic, and chemical physics). The enormous Landscape of Possibilities inherent in our best theory seems to dash that hope.

What further worries many physicists is that the Landscape may be so rich that almost anything can be found: any combination of physical constants, particle masses, etc. This, they fear, would eliminate the predictive power of physics. Environmental facts are nothing more than environmental facts. They worry that if everything is possible, there will be no way to falsify the theory — or, more to the point, no way to confirm it. Is the danger real? We shall see.

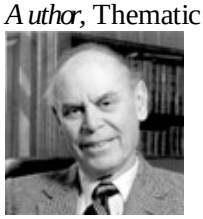
Another danger that some of my colleagues perceive, is that if we "senior physicists" allow ourselves to be seduced by the Anthropic Principle, young physicists will give up looking for the "true" reason for things, the beautiful mathematical principle. My guess is that if the young generation of scientists is really that spineless, then science is doomed anyway. But as we know, the ambition of all young scientists is to make fools of their elders.

And why does the Cardinal Archbishop Schönborn find the Landscape and the Multiverse so dangerous. I will let him explain it himself:

Now, at the beginning of the 21st century, faced with scientific claims like neo-Darwinism and the multiverse hypothesis in cosmology invented to avoid the overwhelming evidence for purpose and design found in modern science, the Catholic Church will again defend human nature by proclaiming that the immanent design evident in nature is real. Scientific theories that try to explain away the appearance of design as the result of 'chance and necessity' are not scientific at all, but, as John Paul put it, an abdication of human intelligence.

Abdication of human intelligence? No, it's called science.

GERALD HOLTON
Mallinckrodt Research Professor of Physics and Research Professor of History of Science, Harvard University; Author, Thematic Origins of Scientific Thought



The medication of the ancient yearning for immortality

Since the major absorption of scientific method into the research and practice of medicine in the 1860s, the longevity curve, at least for the white population in industrial countries, took off and has continued fairly constantly. That has been on the whole a benign result, and has begun to introduce the idea of tolerably good health as one of the basic Human Rights. But one now reads of projections to 200 years, and perhaps more. The economic, social and human costs of the increasing fraction of very elderly citizens have begun to be noticed

already.

To glimpse one of the possible results of the continuing projection of the longevity curve in terms of a plausible scenario: The matriarch of the family, on her deathbed at age 200, is being visited by the surviving, grieving family members: a son and a daughter, each of age of about 180, plus / their/ three "children" , around 150-160 years old each, plus all their offspring, in the range of 120 to 130, and so on..... A touching picture. But what are all the "costs" involved?

CHARLES SEIFE
Professor of Journalism, New York University; formerly journalist, Science *magazine; Author,* Zero: The Biography Of A Dangerous Idea

Nothing

Nothing can be more dangerous than nothing.

Humanity's always been uncomfortable with zero and the void. The ancient Greeks declared them unnatural and unreal. Theologians argued that God's first act was to banish the void by the act of creating the universe ex nihilo, and Middle-Ages thinkers tried to ban zero and the other Arabic "ciphers." But the emptiness is all around us — most of the universe is void. Even as we huddle around our hearths and invent stories to convince ourselves that the cosmos is warm and full and inviting, nothingness stares back at us with empty eye sockets.

KARL SABBAGH
Writer and Television Producer; Author, The Riemann Hypothesis

The human brain and its products are incapable of understanding the truths about the universe

Our brains may never be well-enough equipped to understand the universe and we are fooling ourselves if we think they will.

Why should we expect to be able eventually to understand how the universe originated, evolved, and operates? While human brains are complex and capable of many amazing things,

there is not necessarily any match between the complexity of the universe and the complexity of our brains, any more than a dog's brain is capable of understanding every detail of the world of cats and bones, or the dynamics of stick trajectories when thrown. Dogs get by and so do we, but do we have a right to expect that the harder we puzzle over these things the nearer we will get to the truth? Recently I stood in front of a three metre high model of the Ptolemaic universe in the Museum of the History of Science in Florence and I remembered how well that worked as a representation of the motions of the planets until Copernicus and Kepler came along.

Nowadays, no element of the theory of giant interlocking cogwheels at work is of any use in understanding the motions of the stars and planets (and indeed Ptolemy himself did not argue that the universe really was run by giant cogwheels). Occam's Razor is used to compare two theories and allow us to choose which is more likely to be 'true' but hasn't it become a comfort blanket whenever we are faced with aspects of the universe that seem unutterably complex — string theory for example. But is string theory just the Ptolemaic clockwork *de nos jours*? Can it be succeeded by some simplification or might the truth be even more complex and far beyond the neural networks of our brain to understand?

The history of science is littered with examples of two types of knowledge advancement. There is imperfect understanding that 'sort of' works, and is then modified and replaced by something that works better, without destroying the validity of the earlier theory. Newton's theory of gravitation replaced by Einstein. Then there is imperfect understanding that is replaced by some new idea which owes nothing to older ones. Phlogiston theory, the ether, and so on are replaced by ideas which save the phenomena, lead to predictions, and convince us that they are nearer the truth. Which of these categories really covers today's science? Could we be fooling ourselves by playing around with modern phlogiston?

And even if we are on the right lines in some areas, how much of what there is to be understood in the universe do we really understand? Fifty percent? Five percent? The dangerous idea is that perhaps we understand half a percent and all the brain and computer power we can muster may take us up to one or two percent in the lifetime of the human race.

Paradoxically, we may find that the only justification for pursuing scientific knowledge is for the practical applications it leads to — a view that runs contrary to the traditional support of knowledge for knowledge's sake. And why is this paradoxical? Because the most important advances in technology have come out of research that was not seeking to develop those advances but to understand the universe.

So if my dangerous idea is right — that the human brain and its products are actually incapable of understanding the truths about the universe — it will not — and should not — lead to any diminution at all in our attempts to do so. Which means, I suppose, that it's not really dangerous at all.

RUPERT SHELDRAKE
Biologist, London; Author of The Presence of the Past

A sense of direction involving new scientific principles

We don't understand animal navigation.

No one knows how pigeons home, or how swallow migrate, or how green turtles find Ascension Island from thousands of miles away to lay their eggs. These kinds of navigation involve more than following familiar landmarks, or orientating in a particular compass direction; they involve an ability to move towards a goal.

Why is this idea dangerous? Don't we just need a bit more time to explain navigation in terms of standard physics, genes, nerve impulses and brain chemistry? Perhaps.

But there is a dangerous possibility that animal navigation may not be explicable in terms of present-day physics. Over and above the known senses, some species of animals may have a sense of direction that depends on their being attracted towards their goals through direct field-like connections. These spatial attractors are places with which the animals themselves are already familiar, or with which their ancestors were familiar.

What are the facts? We know more about pigeons than any other species. Everyone agrees that within familiar territory, especially within a few miles of their home, pigeons can use landmarks; for example, they can follow roads. But using familiar landmarks near home cannot explain how racing pigeons return across unfamiliar terrain from six hundred miles away, even flying over the sea, as English pigeons do when they are raced from Spain.

Charles Darwin, himself a pigeon fancier, was one of the first to suggest a scientific hypothesis for pigeon homing. He proposed that they might use a kind of dead reckoning, registering all the twists and turns of the outward journey. This idea was tested in the twentieth century by taking pigeons away from their loft in closed vans by devious routes. They still homed normally. So did birds transported on rotating turntables, and so did birds that had been completely anaesthetized during the outward journey.

What about celestial navigation? One problem for hypothetical solar or stellar navigation systems is that many animals still navigate in cloudy weather. Another problem is that celestial navigation depends on a precise time sense. To test the sun navigation theory, homing pigeons were clock-shifted by six or twelve hours and taken many miles from their lofts before being released. On sunny days, they set off in the wrong direction, as if a clock-dependent sun compass had been shifted. But in spite of their initial confusion, the pigeons soon corrected their courses and flew homewards normally.

Two main hypotheses remain: smell and magnetism. Smelling the home position from

hundreds of miles away is generally agreed to be implausible. Even the most ardent defenders of the smell hypothesis (the Italian school of Floriano Papi and his colleagues) concede that smell navigation is unlikely to work at distances over 30 miles.

That leaves a magnetic sense. A range of animal species can detect magnetic fields, including termites, bees and migrating birds. But even if pigeons have a compass sense, this cannot by itself explain homing. Imagine that you are taken to an unfamiliar place and given a compass. You will know from the compass where north is, but not where home is.

The obvious way of dealing with this problem is to postulate complex interactions between known sensory modalities, with multiple back-up systems. The complex interaction theory is safe, sounds sophisticated, and is vague enough to be irrefutable. The idea of a sense of direction involving new scientific principles is dangerous, but it may be inevitable.

TOR NØRRETRANDERS
Science Writer; Consultant; Lecturer, Copenhagen; Author, The User Illusion

Social Relativity

Relativity is my dangerous idea. Well, neither the special nor the general theory of relativity, but what could be called *social relativity:* The idea that the only thing that matters to human well-being is how one stands relatively to others. That is, only the relative wealth of a person is important, the absolute level does not really matter, as soon as everyone is above the level of having their immediate survival needs fulfilled.

There is now strong and consistent evidence (from fields such as microeconomics, experimental economics, psychology, sociolology and primatology) that it doesn't really matter how much you earn, as long as you earn more than your wife's sister's husband. Pioneers in these discussions are the late British social thinker Fred Hirsch and the American economist Robert Frank.

Why is this idea dangerous? It seems to imply that equality will never become possible in human societies: The driving force is always to get ahead of the rest. Nobody will ever settle down and share.

So it would seem that we are forever stuck with poverty, disease and unjust hierarchies. This idea could make the rich and the smart lean back and forget about the rest of the pack.

But it shouldn't.

Inequality may subjectively seem nice to the rich, but objectively it is not in their interest.

A huge body of epidemiological evidence points to the fact that inequality is in fact the prime cause for human disease. Rich people in poor countries are more healthy than poor people in rich countries, even though the latter group has more resources in absolute terms. Societies with strong gradients of wealth show higher death rates and more disease, also amongst the people at the top. Pioneers in these studies are the British epidemiologists Michael Marmot and Richard Wilkinson.

Poverty means spreading of disease, degradation of ecosystems and social violence and crime — which are also bad for the rich. Inequality means stress to everyone.

Social relativity then boils down to an illusion: It seems nice to me to be better off than the rest, but in terms of vitals — survival, good health — it is not.

Believing in social relativity can be dangerous to your health.

JOHN HORGAN
Science Writer; Author, Rational Mysticism

We Have No Souls

The Depressing, Dangerous Hypothesis: We Have No Souls.

This year's *Edge* question makes me wonder: Which ideas pose a greater potential danger? False ones or true ones? Illusions or the lack thereof? As a believer in and lover of science, I certainly hope that the truth will set us free, and save us, but sometimes I'm not so sure.

The dangerous, probably true idea I'd like to dwell on in this Holiday season is that we humans have no souls. The soul is that core of us that supposedly transcends and even persists beyond our physicality, lending us a fundamental autonomy, privacy and dignity. In his 1994 book The Astonishing Hypothesis: *The Scientific Search for the Soul*, the late, great Francis Crick argued that the soul is an illusion perpetuated, like Tinkerbell, only by our belief in it. Crick opened his book with this manifesto: "'You,' your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behavior of a vast assembly of nerve cells and their associated molecules." Note the quotation marks around "You." The subtitle of Crick's book was almost comically ironic, since he was clearly trying not to find the soul but to crush it out of existence.

I once told Crick that "The Depressing Hypothesis" would have been a more accurate title for

his book, since he was, after all, just reiterating the basic, materialist assumption of modern neurobiology and, more broadly, all of science. Until recently, it was easy to dismiss this assumption as moot, because brain researchers had made so little progress in tracing cognition to specific neural processes. Even self-proclaimed materialists — who accept, intellectually, that we are just meat machines — could harbor a secret, sentimental belief in a soul of the gaps. But recently the gaps have been closing, as neuroscientists — egged on by Crick in the last two decades of his life--have begun unraveling the so-called neural code, the software that transforms electrochemical pulses in the brain into perceptions, memories, decisions, emotions, and other constituents of consciousness.

I've argued elsewhere that the neural code may turn out to be so complex that it will never be fully deciphered. But 60 years ago, some biologists feared the genetic code was too complex to crack. Then in 1953 Crick and Watson unraveled the structure of DNA, and researchers quickly established that the double helix mediates an astonishingly simple genetic code governing the heredity of all organisms. Science's success in deciphering the genetic code, which has culminated in the Human Genome Project, has been widely acclaimed — and with good reason, because knowledge of our genetic makeup could allow us to reshape our innate nature. A solution to the neural code could give us much greater, more direct control over ourselves than mere genetic manipulation.

Will we be liberated or enslaved by this knowledge? Officials in the Pentagon, the major funder of neural-code research, have openly broached the prospect of cyborg warriors who can be remotely controlled via brain implants, like the assassin in the recent remake of "The Manchurian Candidate." On the other hand, a cult-like group of self-described "wireheads" looks forward to the day when implants allow us to create our own realities and achieve ecstasy on demand.

Either way, when our minds can be programmed like personal computers, then, perhaps, we will finally abandon the belief that we have immortal, inviolable souls, unless, of course, we program ourselves to believe.

ERIC R. KANDEL
Biochemist and University Professor, Columbia University; Recipient, The Nobel Prize, 2000; Author, Cellular Basis of Behavior

Free will is exercised unconsciously, without awareness

It is clear that consciousness is central to understanding human mental processes, and therefore is the holy grail of modern neuroscience. What is less clear is that much of our mental processes are unconscious and that these unconscious processes are as important as

conscious mental processes for understanding the mind. Indeed most cognitive processes never reach consciousness.

As Sigmund Freud emphasized at the beginning of the 20th century most of our perceptual and cognitive processes are unconscious, except those that are in the immediate focus of our attention. Based on these insights Freud emphasized that unconscious mental processes guide much of human behavior.

Freud's idea was a natural extension of the notion of *unconscious inference* proposed in the 1860s by Hermann Helmholtz, the German physicist turned neural scientist. Helmholtz was the first to measure the conduction of electrical signals in nerves. He had expected it to be as the speed of light, fast as the conduction of electricity in copper cables, and found to his surprise that it was much slower, only about 90m sec. He then examined the reaction time, the time it takes a subject to respond to a consciously a perceived stimulus, and found that it was much, much slower than even the combined conduction times required for sensory and motor activities.

This caused Helmholz to argue that a great deal of brain processing occurred unconsciously prior to conscious perception of an object. Helmholtz went on to argue that much of what goes on in the brain is not represented in consciousness and that the perception of objects depends upon "unconscious inferences" made by the brain, based on thinking and reasoning without awareness. This view was not accepted by many brain scientists who believed that consciousness is necessary for making inferences. However, in the 1970s a number of experiments began to accumulate in favor of the idea that most cognitive processes that occur in the brain never enter consciousness.

Perhaps the most influential of these experiments were those carried out by Benjamin Libet in 1986. Libet used as his starting point a discovery made by the German neurologist Hans Kornhuber. Kornhuber asked volunteers to move their right index finger. He then measured this voluntary movement with a strain gauge while at the same time recording the electrical activity of the brain by means of an electrode on the skull. After hundreds of trials, Kornhuber found that, invariably, each movement was preceded by a little blip in the electrical record from the brain, a spark of free will! He called this potential in the brain the "readiness potential" and found that it occurred one second before the voluntary movement.

Libet followed up on Kornhuber's finding with an experiment in which he asked volunteers to lift a finger whenever they felt the urge to do so. He placed an electrode on a volunteer's skull and confirmed a readiness potential about one second before the person lifted his or her finger. He then compared the time it took for the person to will the movement with the time of the readiness potential.

Amazingly, Libet found that the readiness potential appeared not after, but 200 milliseconds *before* a person felt the urge to move his or her finger! Thus by merely observing the electrical activity of the brain, Libet could predict what a person would do before the person was actually aware of having decided to do it.

These experiments led to the radical insight that by observing another person's brain activity,

one can predict what someone is going to do before he is aware that he has made the decision to do it. This finding has caused philosophers of mind to ask: If the choice is determined in the brain *unconsciously* before we decide to act, where is free will?

Are these choices predetermined? Is our experience of freely willing our actions only an illusion, a rationalization after the fact for what has happened? Freud, Helmholtz and Libet would disagree and argue that the choice is freely made but that it happens without our awareness. According to their view, the unconscious inference of Helmholtz also applies to decision-making.

They would argue that the choice is made freely, but not consciously. Libet for example proposes that the process of initiating a voluntary action occurs in an unconscious part of the brain, but that just before the action is initiated, consciousness is recruited to approve or veto the action. In the 200 milliseconds before a finger is lifted, consciousness determines whether it moves or not.

Whatever the reasons for the delay between decision and awareness, Libet's findings now raise the moral question: Is one to be held responsible for decisions that are made without conscious awareness?

DANIEL GOLEMAN
Psychologist; Author, Emotional Intelligence

Cyber-disinhibition

The Internet inadvertently undermines the quality of human interaction, allowing destructive emotional impulses freer reign under specific circumstances. The reason is a neural fluke that results in cyber-disinhibition of brain systems that keep our more unruly urges in check. The tech problem: a major disconnect between the ways our brains are wired to connect, and the interface offered in online interactions.

Communication via the Internet can mislead the brain's social systems. The key mechanisms are in the prefrontal cortex; these circuits instantaneously monitor ourselves and the other person during a live interaction, and automatically guide our responses so they are appropriate and smooth. A key mechanism for this involves circuits that ordinarily inhibit impulses for actions that would be rude or simply inappropriate — or outright dangerous.

In order for this regulatory mechanism to operate well, we depend on real-time, ongoing feedback from the other person. The Internet has no means to allow such realtime feedback (other than rarely used two-way audio/ video streams). That puts our inhibitory circuitry at a

loss — there is no signal to monitor from the other person. This results in disinhibition: impulse unleashed.

Such disinhibition seems state-specific, and typically occurs rarely while people are in positive or neutral emotional states. That's why the Internet works admirably for the vast majority of communication. Rather, this disinhibition becomes far more likely when people feel strong, negative emotions. What fails to be inhibited are the impulses those emotions generate.

This phenomenon has been recognized since the earliest days of the Internet (then the Arpanet, used by a small circle of scientists) as "flaming," the tendency to send abrasive, angry or otherwise emotionally "off" cyber-messages. The hallmark of a flame is that the same person would never say the words in the email to the recipient were they face-to-face. His inhibitory circuits would not allow it — and so the interaction would go more smoothly. He might still communicate the same core information face-to-face, but in a more skillful manner. Offline and in life, people who flame repeatedly tend to become friendless, or get fired (unless they already run the company).

The greatest danger from cyber-disinhibition may be to young people. The prefrontal inhibitory circuitry is among the last part of the brain to become fully mature, doing so sometime in the twenties. During adolescence there is a developmental lag, with teenagers having fragile inhibitory capacities, but fully ripe emotional impulsivity.

Strengthening these inhibitory circuits can be seen as the singular task in neural development of the adolescent years.

One way this teenage neural gap manifests online is "cyber-bullying," which has emerged among girls in their early teens. Cliques of girls post or send cruel, harassing messages to a target girl, who typically is both reduced to tears and socially humiliated. The posts and messages are anonymous, though they become widely known among the target's peers. The anonymity and social distance of the Internet allow an escalation of such petty cruelty to levels that are rarely found in person: face-to-face seeing someone cry typically halts bullying among girls — but that inhibitory signal cannot come via Internet.

A more ominous manifestation of cyber-disinhibition can be seen in the susceptibility of teenagers induced to perform sexual acts in front of webcams for an anonymous adult audience who pay to watch and direct. Apparently hundreds of teenagers have been lured into this corner of child pornography, with an equally large audience of pedophiles. The Internet gives strangers access to children in their own homes, who are tempted to do things online they would never consider in person.

Cyber-bullying was reported last week in my local paper. The Webcam teenage sex circuit was a front-page story in *The New York Times* two days later.

As with any new technology, the Internet is an experiment in progress. It's time we considered what other such downsides of cyber-disinhibition may be emerging — and looked for a technological fix, if possible. The dangerous thought: the Internet may harbor social perils our

inhibitory circuitry was not designed to handle in evolution.

BRIAN GREENE

Physicist & Mathematician, Columbia University; Author, The Fabric of the Cosmos*; Presenter, three-part Nova program,* The Elegant Universe

The Multiverse

The notion that there are universes beyond our own — the idea that we are but one member of a vast collection of universes called the multiverse — is highly speculative, but both exciting and humbling. It's also an idea that suggests a radically new, but inherently risky approach to certain scientific problems.

An essential working assumption in the sciences is that with adequate ingenuity, technical facility, and hard work, we can explain what we observe. The impressive progress made over the past few hundred years is testament to the apparent validity of this assumption. But if we are part of a multiverse, then our universe may have properties that are beyond traditional scientific explanation. Here's why:

Theoretical studies of the multiverse (within inflationary cosmology and string theory, for example) suggest that the detailed properties of the other universes may be significantly different from our own. In some, the particles making up matter may have different masses or electric charges; in others, the fundamental forces may differ in strength and even number from those we experience; in others still, the very structure of space and time may be unlike anything we've ever seen.

In this context, the quest for fundamental explanations of particular properties of our universe — for example, the observed strengths of the nuclear and electromagnetic forces — takes on a very different character. The strengths of these forces may vary from universe to universe and thus it may simply be a matter of chance that, in our universe, these forces have the particular strengths with which we're familiar. More intriguingly, we can even imagine that in the other universes where their strengths are different, conditions are not hospitable to our form of life. (With different force strengths, the processes giving rise to long-lived stars and stable planetary systems — on which life can form and evolve — can easily be disrupted.) In this setting, there would be no deep explanation for the observed force strengths. Instead, we would find ourselves living in a universe in which the forces have their familiar strengths simply because we couldn't survive in any of the others where the strengths were different.

If true, the idea of a multiverse would be a Copernican revolution realized on a cosmic scale. It would be a rich and astounding upheaval, but one with potentially hazardous consequences.

Beyond the inherent difficulty in assessing its validity, when should we allow the multiverse framework to be invoked in lieu of a more traditional scientific explanation? Had this idea surfaced a hundred years ago, might researchers have chalked up various mysteries to how things just happen to be in our corner of the multiverse, and not pressed on to discover all the wondrous science of the last century?

Thankfully that's not how the history of science played itself out, at least not in our universe. But the point is manifest. While some mysteries may indeed reflect nothing more than the particular universe, within the multiverse, we find ourselves inhabiting, other mysteries are worth struggling with because they are the result of deep, underlying physical laws. The danger, if the multiverse idea takes root, is that researchers may too quickly give up the search for such underlying explanations. When faced with seemingly inexplicable observations, researchers may invoke the framework of the multiverse prematurely — proclaiming some or other phenomenon to merely reflect conditions in our bubble universe — thereby failing to discover the deeper understanding that awaits us.

DAVID GELERNTER
Computer Scientist, Yale University; Chief Scientist, Mirror Worlds Technologies; Author, Drawing Life

What are people well-informed about in the Information Age?

Let's date the Information Age to 1982, when the Internet went into operation & the PC had just been born. What if people have been growing less well-informed ever since? What if people have been growing steadily more ignorant ever since the so-called Information Age began?

Suppose an average US voter, college teacher, 5th-grade teacher, 5th-grade student are each less well-informed today than they were in '95, and were less well-informed then than in '85? Suppose, for that matter, they were less well-informed in '85 than in '65?

If this is indeed the "information age," what exactly are people well-informed *about*? Video games? Clearly history, literature, philosophy, scholarship in general are not our specialities. This is some sort of technology age — are people better informed about science? Not that I can tell. In previous technology ages, there was interest across the population in the era's leading technology.

In the 1960s, for example, all sorts of people were interested in the space program and rocket technology. Lots of people learned a little about the basics — what a "service module" or "trans-lunar injection" was, why a Redstone-Mercury vehicle was different from an Atlas-

Mercury — all sorts of grade-school students, lawyers, housewives, English profs were up on these topics. Today there is *no* comparable interest in computers & the internet, and no comparable knowledge. "TCP/ IP," "Routers," "Ethernet protocol," "cache hits" — these are topics of no interest whatsoever outside the technical community. The contrast is striking.

MAHZARIN R. BANAJI
Professor of Psychology, Harvard University

We do not (and to a large extent, cannot) know who we are through introspection

Conscious awareness is a sliver of the machine that is human intelligence but it's the only aspect we experience and hence the only aspect we come to believe exists. Thoughts, feelings, and behavior operate largely without deliberation or conscious recognition — it's the routinized, automatic, classically conditioned, pre-compiled aspects of our thoughts and feelings that make up a large part of who we are. We don't know what motivates us even though we are certain we know just why we do the things we do. We have no idea that our perceptions and judgments are incorrect (as measured objectively) even when they are. Even more stunning, our behavior is often discrepant from our own conscious intentions and goals, not just objective standards or somebody else's standards.

The same lack of introspective access that keeps us from seeing the truth in a visual illusion is the lack of introspective access that keeps us from seeing the truth of our own minds and behavior. The "bounds" on our ethical sense rarely come to light because the input into those decisions is kept firmly outside our awareness. Or at least, they don't come to light until science brings them into the light in a way that no longer permits them to remain in the dark.

It is the fact that human minds have a tendency to categorize and learn in particular ways, that the sorts of feelings for one's ingroup and fear of outgroups are part of our evolutionary history. That fearing things that are different from oneself, holding what's not part of the dominant culture (not American, not male, not White, not college-educated) to be "less good" whether one wants to or not, reflects a part of our history that made sense in a particular time and place - because without it we would not have survived. To know this is to understand the barriers to change honestly and with adequate preparation.

As everybody's favorite biologist Richard Dawkins said thirty years ago:

Let us understand what our own selfish genes are up to, because we may then at least have a chance to upset their designs, something that no other species has ever aspired to do.

We cannot know ourselves without the methods of science. The mind sciences have made it

possible to look into the universe between the ear drums in ways that were unimagined.

Emily Dickinson wrote in a letter to a mentor asking him to tell her how good a poet she was: "The sailor cannot see the north, but knows the needle can" she said. We have the needle and it involves direct, concerted effort, using science to get to the next and perhaps last frontier, of understanding not just our place among other planets, our place among other species, but our very nature.

RODNEY BROOKS

Director, MIT Computer Science and Artificial Intelligence Laboratory (CSAIL); Chief Technical Officer of iRobot Corporation; author Flesh and Machines

Being alone in the universe

The thing that I worry about most that may or may not be true is that perhaps the spontaneous transformation from non-living matter to living matter is extraordinarily unlikely. We know that it has happened once. But what if we gain lots of evidence over the next few decades that it happens very rarely.

In my lifetime we can expect to examine the surface of Mars, and the moons of the gas giants in some detail. We can also expect to be able to image extra-solar planets within a few tens of light years to resolutions where we would be able to detect evidence of large scale biological activity.

What if none of these indicate any life whatsoever? What does that do to our scientific belief that life did arise spontaneously. It should not change it, but it will make it harder to defend against non-scientific attacks. And wouldn't it sadden us immensely if we were to discover that there is a vanishing small probability that life will arise even once in any given galaxy.

Being alone in this solar system will not be such a such a shock, but alone in the galaxy, or worse alone in the universe would, I think, drive us to despair, and back towards religion as our salve.

LEE SMOLIN

Physicist, Perimeter Institute; Author, Three Roads to Quantum Gravity

Seeing Darwin in the light of Einstein; seeing Einstein in the light of Darwin

The revolutionary moves made by Einstein and Darwin are closely related, and their combination will increasingly come to define how we see our worlds: physical, biological and social.

Before Einstein, the properties of elementary particles were understood as being defined against an absolute, eternally fixed background. This way of doing science had been introduced by Newton. His method was to posit the existence of an absolute and eternal background structure against which the properties of things were defined. For example, this is how Newton conceived of space and time. Particles have properties defined, not with respect to each other, but each with respect to only the absolute background of space and time. Einstein's great achievement was to realize successfully the contrary idea, called relationalism, according to which the world is a network of relationships which evolve in time. There is no absolute background and the properties of anything are only defined in terms of its participation in this network of relations.

Before Darwin, species were thought of as eternal categories, defined a priori; after Darwin species were understood to be relational categories-that is only defined in terms of their relationship with the network of interactions making up the biosphere. Darwin's great contribution was to understand that there is a process-natural selection-that can act on relational properties, leading to the birth of genuine novelty by creating complexes of relationships that are increasingly structured and complex.

Seeing Darwin in the light of Einstein, we understand that all the properties a species has in modern biology are relational. There is no absolute background in biology.

Seeing Einstein in the light of Darwin opens up the possibility that the mechanism of natural selection could act not only on living things but on the properties that define the different species of elementary particles.

At first, physicists thought that the only relational properties an elementary particle might have were its position and motion in space and time. The other properties, like mass and charge were thought of in the old framework: defined by a background of absolute law. The standard model of particle physics taught us that some of those properties, like mass, are only the consequence of a particles interactions with other fields. As a result the mass of a particle is determined environmentally, by the phase of the other fields it interacts with.

I don't know which model of quantum gravity is right, but all the leading candidates, string theory, loop quantum gravity and others, teach us that it is possible that all properties of

elementary particles are relational and environmental. In different possible universes there may be different combinations of elementary particles and forces. Indeed, all that used to be thought of as fundamental, space and the elementary particles themselves are increasingly seen, in models of quantum gravity, as themselves emergent from a more elementary network of relations.

The basic method of science after Einstein seems to be: identify something in your theory that is playing the role of an absolute background, that is needed to define the laws that govern objects in your theory, and understand it more deeply as a contingent property, which itself evolves subject to law.

For example, before Einstein the geometry of space was thought of as specified absolutely as part of the laws of nature. After Einstein we understand geometry is contingent and dynamical, which means it evolves subject to law. This means that Einstein's move can even be applied to aspects of what were thought to be the laws of nature: so that even aspects of the laws turn out to evolve in time.

The basic method of science after Darwin seems to be to identify some property once thought to be absolute and defined a prior and recognize that it can be understood because it has evolved by a process of or akin to natural selection. This has revolutionized biology and is in the process of doing the same to the social sciences.

We can see by how I have stated it that these two methods are closely related. Einstein emphasizes the relational aspect of all properties described by science, while Darwin proposes that ultimately, the law which governs the evolution of everything else, including perhaps what were once seen to be laws-is natural selection.

Should Darwin's method be applied even to the laws of physics? Recent developments in elementary particle physics give us little alternative if we are to have a rational understanding of the laws that govern our universe. I am referring here to the realization that string theory gives us, not a unique set of particles and forces, but an infinite list out of which one came to be selected for our universe. We physicists have now to understand Darwin's lesson: the only way to understand how one out of a vast number of choices was made, which favors improbably structure, is that it is the result of evolution by natural selection.

Can this work? I showed it might, in 1992, in a theory of cosmological natural selection. This remains the only theory of how our laws came to be selected so far proposed that makes falsifiable predictions.

The idea that laws of nature are themselves the result of evolution by natural selection is nothing new, it was anticipated by the philosopher Charles Sanders Pierce, who wrote in 1891:

To suppose universal laws of nature capable of being apprehended by the mind and yet having no reason for their special forms, but standing inexplicable and irrational, is hardly a justifiable position. Uniformities are precisely the sort of facts that need to be accounted for. Law is par excellence the thing that wants a reason. Now the only possible way of accounting for the laws of nature, and for uniformity in general, is to suppose

them results of evolution.

This idea remains dangerous, not only for what it has achieved, but for what it implies for the future. For there are implications have yet to be absorbed or understood, even by those who have come to believe it is the only way forward for science. For example, must there always be a deeper, or meta-law, which governs the physical mechanisms by which a law evolves? And what about the fact that laws of physics are expressed in mathematics, which is usually thought of as encoding eternal truths? Can mathematics itself come to be seen as time bound rather that as transcendent and eternal platonic truths?

I believe that we will achieve clarity on these and other scary implications of the idea that all the regularities we observe, including those we have gotten used to calling laws, are the result of evolution by natural selection. And I believe that once this is achieved Einstein and Darwin will be understood as partners in the greatest revolution yet in science, a revolution that taught us that the world we are imbedded in is nothing but an ever evolving network of relationships.

ALISON GOPNIK
Psychologist, UC-Berkeley; Coauthor, The Scientist In the Crib

A cacophony of "controversy"

It may not be good to encourage scientists to articulate dangerous ideas.

Good scientists, almost by definition, tend towards the contrarian and ornery, and nothing gives them more pleasure than holding to an unconventional idea in the face of opposition. Indeed, orneriness and contrarianism are something of currency for science — nobody wants to have an idea that everyone else has too. Scientists are always constructing a straw man "establishment" opponent who they can then fearlessly demolish. If you combine that with defying the conventional wisdom of non-scientists you have a recipe for a very distinctive kind of scientific smugness and self-righteousness. We scientists see this contrarian habit grinning back at us in a particularly hideous and distorted form when global warming opponents or intelligent design advocates invoke the unpopularity of their ideas as evidence that they should be accepted, or at least discussed.

The problem is exacerbated for public intellectuals. For the media too, would far rather hear about contrarian or unpopular or morally dubious or "controversial" ideas than ones that are congruent with everyday morality and wisdom. No one writes a newspaper article about a study that shows that girls are just as good at some task as boys, or that children are influenced by their parents.

It is certainly true that there is no reason that scientifically valid results should have morally comforting consequences — but there is no reason why they shouldn't either. Unpopularity or shock is no more a sign of truth than popularity is. More to the point, when scientists do have ideas that are potentially morally dangerous they should approach those ideas with hesitancy and humility. And they should do so in full recognition of the great human tragedy that, as Isiah Berlin pointed out, there can be genuinely conflicting goods and that humans are often in situations of conflict for which there is no simple or obvious answer.

Truth and morality may indeed in some cases be competing values, but that is a tragedy, not a cause for self-congratulation. Humility and empathy come less easily to most scientists, most certainly including me, than pride and self-confidence, but perhaps for that very reason they are the virtues we should pursue.

This is, of course, itself a dangerous idea. Orneriness and contrarianism are in fact, genuine scientific virtues, too. And in the current profoundly anti-scientific political climate it is terribly dangerous to do anything that might give comfort to the enemies of science. But I think the peril to science actually doesn't lie in timidity or self-censorship. It is much more likely to lie in a cacophony of "controversy".

KEVIN KELLY
Editor-At-Large, Wired; Author, New Rules for the New Economy

More anonymity is good

More anonymity is good: that's a dangerous idea.

Fancy algorithms and cool technology make true anonymity in mediated environments more possible today than ever before. At the same time this techno-combo makes true anonymity in physical life much harder. For every step that masks us, we move two steps toward totally transparent unmasking. We have caller ID, but also caller ID Block, and then caller ID-only filters. Coming up: biometric monitoring and little place to hide. A world where everything about a person can be found and archived is a world with no privacy, and therefore many technologists are eager to maintain the option of easy anonymity as a refuge for the private.

However in every system that I have seen where anonymity becomes common, the system fails. The recent taint in the honor of Wikipedia stems from the extreme ease which anonymous declarations can be put into a very visible public record. Communities infected with anonymity will either collapse, or shift the anonymous to pseudo-anonymous, as in eBay, where you have a traceable identity behind an invented nickname. Or voting, where you can

authenticate an identity without tagging it to a vote.

Anonymity is like a rare earth metal. These elements are a necessary ingredient in keeping a cell alive, but the amount needed is a mere hard-to-measure trace. In larger does these heavy metals are some of the most toxic substances known to a life. They kill. Anonymity is the same. As a trace element in vanishingly small doses, it's good for the system by enabling the occasional whistleblower, or persecuted fringe. But if anonymity is present in any significant quantity, it will poison the system.

There's a dangerous idea circulating that the option of anonymity should always be at hand, and that it is a noble antidote to technologies of control. This is like pumping up the levels of heavy metals in your body into to make it stronger.

Privacy can only be won by trust, and trust requires persistent identity, if only pseudo-anonymously. In the end, the more trust, the better. Like all toxins, anonymity should be keep as close to zero as possible.

DENIS DUTTON
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A "grand narrative"

The humanities have gone through the rise of Theory in the 1960s, its firm hold on English and literature departments through the 1970s and 80s, followed most recently by its much-touted decline and death.

Of course, Theory (capitalization is an English department affectation) never operated as a proper research program in any scientific sense — with hypotheses validated (or falsified) by experiment or accrued evidence. Theory was a series of intellectual fashion statements, clever slogans and postures, imported from France in the 60s, then developed out of Yale and other Theory hot spots. The academic work Theory spawned was noted more for its chosen jargons, which functioned like secret codes, than for any concern to establish truth or advance knowledge. It was all about careers and prestige.

Truth and knowledge, in fact, were ruled out as quaint illusions. This cleared the way, naturally, for an "anything-goes" atmosphere of academic criticism. In reality, it was anything but anything goes, since the political demands of the period included a long list of stereotyped villains (the West, the Enlightenment, dead whites males, even clear writing) to be pitted against mandatory heroines and heroes (indigenous peoples, the working class, the oppressed,

and so forth).

Though the politics remains as strong as ever in academe, Theory has atrophied not because it was refuted, but because everyone got bored with it. Add to that the absurdly bad writing of academic humanists of the period and episodes like the Sokal Hoax, and the decline was inevitable. Theory academics could with high seriousness ignore rational counter-arguments, but for them ridicule and laughter were like water thrown at the Wicked Witch. Theory withered and died.

But wait. Here is exactly where my most dangerous idea comes in. What if it turned out that the academic humanities — art criticism, music and literary history, aesthetic theory, and the philosophy of art — actually had available to them a true, and therefore permanently valuable, theory to organize their speculations and interpretations? What if there really existed a hitherto unrecognized "grand narrative" that could explain the entire history of creation and experience of the arts worldwide?

Aesthetic experience, as well as the context of artistic creation, is a phenomenon both social and psychological. From the standpoint of inner experience, it can be addressed by evolutionary psychology: the idea that our thinking and values are conditioned by the 2.6 million years of natural and sexual selection in the Pleistocene.

This Darwinian theory has much to say about the abiding, cross-culturally ascertainable values human beings find in art. The fascination, for example, that people worldwide find in the exercise of artistic virtuosity, from Praxiteles to Hokusai to Renee Fleming, is not a social construct, but a Pleistocene adaptation (which outside of the arts shows itself in sporting interests everywhere). That calendar landscapes worldwide feature alternating copses of trees and open spaces, often hilly land, water, and paths or river banks that wind into an inviting distance is a Pleistocene landscape preference (which shows up in both art history and in the design of public parks everywhere). That soap operas and Greek tragedy all present themes of family breakdown ("She killed him because she loved him") is a reflection of ancient, innate content interests in story-telling.

Darwinian theory offers substantial answers to perennial aesthetic questions. It has much to say about the origins of art. It's unlikely that the arts came about at one time or for one purpose; they evolved from overlapping interests based in survival and mate selection in the 80,000 generations of the Pleistocene. How we scan visually, how we hear, our sense of rhythm, the pleasures of artistic expression and in joining with others as an audience, and, not least, how the arts excite us using a repertoire of universal human emotions: all of this and more will be illuminated and explained by a Darwinian aesthetics.

I've encountered stiff academic resistance to the notion that Darwinian theory might greatly improve the understanding of our aesthetic and imaginative lives. There's no reason to worry. The most complete, evolutionarily-based explanation of a great work of art, classic or recent, will address its form, its narrative content, its ideology, how it is taken in by the eye or mind, and indeed, how it can produce a deep, even life-transforming pleasure. But nothing in a valid aesthetic psychology will rob art of its appeal, any more than knowing how we evolved to enjoy fat and sweet makes a piece of cheesecake any less delicious. Nor will a Darwinian

aesthetics reduce the complexity of art to simple formulae. It will only give us a better understanding of the greatest human achievements and their effects on us.

In the sense that it would show innumerable careers in the humanities over the last forty years to have been wasted on banal politics and execrable criticism, Darwinian aesthetics is a very dangerous idea indeed. For people who really care about understanding art, it would be a combination of fresh air and strong coffee.

SIMON BARON-COHEN
Psychologist, Autism Research Centre, Cambridge University; Author, The Essential Difference

A political system based on empathy

Imagine a political system based not on legal rules (systemizing) but on empathy. Would this make the world a safer place?

The UK Parliament, US Congress, Israeli Knesset, French National Assembly, Italian Senato della Repubblica, Spanish Congreso de los Diputados, — what do such political chambers have in common? Existing political systems are based on two principles: getting power through combat, and then creating/ revising laws and rules through combat.

Combat is sometimes physical (toppling your opponent militarily), sometimes economic (establishing a trade embargo, to starve your opponent of resources), sometimes propaganda-based (waging a media campaign to discredit your opponent's reputation), and sometimes through voting-related activity (lobbying, forming alliances, fighting to win votes in key seats), with the aim to 'defeat' the opposition.

Creating/ revising laws and rules is what you do once you are in power. These might be constitutional rules, rules of precedence, judicial rulings, statutes, or other laws or codes of practice. Politicians battle for their rule-based proposal (which they hold to be best) to win, and battle to defeat the opposition's rival proposal.

This way of doing politics is based on "systemizing". First you analyse the most effective form of combat (itself a system) to win. If we do x, then we will obtain outcome y. Then you adjust the legal code (another system). If we pass law A, we will obtain outcome B.

My colleagues and I have studied the essential difference between how men and women think. Our studies suggest that (on average) more men are systemizers, and more women are empathizers. Since most political systems were set up by men, it may be no coincidence that

we have ended up with political chambers that are built on the principles of systemizing.

So here's the dangerous new idea. What would it be like if our political chambers were based on the principles of empathizing? It is dangerous because it would mean a revolution in how we choose our politicians, how our political chambers govern, and how our politicians think and behave. We have never given such an alternative political process a chance. Might it be better and safer than what we currently have? Since empathy is about keeping in mind the thoughts and feelings of other people (not just your own), and being sensitive to another person's thoughts and feelings (not just riding rough-shod over them), it is clearly incompatible with notions of "doing battle with the opposition" and "defeating the opposition" in order to win and hold on to power.

Currently, we select a party (and ultimately a national) leader based on their "leadership" qualities. Can he or she make decisions decisively? Can they do what is in the best interests of the party, or the country, even if it means sacrificing others to follow through on a decision? Can they ruthlessly reshuffle their Cabinet and "cut people loose" if they are no longer serving their interests? These are the qualities of a strong systemizer.

Note we are not talking about whether that politician is male or female. We are talking about how a politician (irrespective of their sex) thinks and behaves.

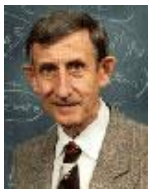
We have had endless examples of systemizing politicians unable to resolve conflict. Empathizing politicians would perhaps follow Mandela and De Klerk's examples, who sat down to try to understand the other, to empathize with the other, even if the other was defined as a terrorist. To do this involves the empathic act of stepping into the other's shoes, and identifying with their feelings.

The details of a political system based on empathizing would need a lot of working out, but we can imagine certain qualities that would have no place.

Gone would be politicians who are skilled orators but who simply deliver monologues, standing on a platform, pointing forcefully into the air to underline their insistence — even the body language containing an implied threat of poking their listener in the chest or the face - to win over an audience. Gone too would be politicians who are so principled that they are rigid and uncompromising.

Instead, we would elect politicians based on different qualities: politicians who are good listeners, who ask questions of others instead of assuming they know the right course of action. We would instead have politicians who respond sensitively to another, different point of view, and who can be flexible over where the dialogue might lead. Instead of seeking to control and dominate, our politicians would be seeking to support, enable, and care.

FREEMAN DYSON
Physicist, Institute of Advanced Study, Author, Disturbing the Universe



Biotechnology will be thoroughly domesticated in the next fifty years

Biotechnology will be domesticated in the next fifty years as thoroughly as computer technology was in the last fifty years.

This means cheap and user-friendly tools and do-it-yourself kits, for gardeners to design their own roses and orchids, and for animal-breeders to design their own lizards and snakes. A new art-form as creative as painting or cinema. It means biotech games for children down to kindergarten age, like computer-games but played with real eggs and seeds instead of with images on a screen. Kids will grow up with an intimate feeling for the organisms that they create. It means an explosion of biodiversity as new ecologies are designed to fit into millions of local niches all over the world. Urban and rural landscapes will become more varied and more fertile.

There are two severe and obvious dangers. First, smart kids and malicious grown-ups will find ways to convert biotech tools to the manufacture of lethal microbes. Second, ambitious parents will find ways to apply biotech tools to the genetic modification of their own babies. The great unanswered question is, whether we can regulate domesticated biotechnology so that it can be applied freely to animals and vegetables but not to microbes and humans.

GREGORY COCHRAN

Consultant in adaptive optics and an adjunct professor of anthropology at the University of Utah

There is something new under the sun — us

Thucydides said that human nature was unchanging and thus predictable — but he was probably wrong. If you consider natural selection operating in fast-changing human environments, such stasis is most unlikely. We know of a number of cases in which there has been rapid adaptive change in humans; for example, most of the malaria-defense mutations such as sickle cell are recent, just a few thousand years old. The lactase mutation that lets most adult Europeans digest ice cream is not much older.

There is no magic principle that restricts human evolutionary change to disease defenses and dietary adaptations: everything is up for grabs. Genes affecting personality, reproductive

strategies, cognition, are all able to change significantly over few-millennia time scales if the environment favors such change — and this includes the new environments we have made for ourselves, things like new ways of making a living and new social structures. I would be astonished if the mix of personality types favored among hunter-gatherers is "exactly" the same as that favored among peasant farmers ruled by a Pharaoh. In fact they might be fairly different.

There is evidence that such change has occurred. Henry Harpending and I have, we think, made a strong case that natural selection changed the Ashkenazi Jews over a thousand years or so, favoring certain kinds of cognitive abilities and generating genetic diseases as a side effect. Bruce Lahn's team has found new variants of brain-development genes: one, ASPM, appears to have risen to high frequency in Europe and the Middle East in about six thousand years. We don't yet know what this new variant does, but it certainly could affect the human psyche — and if it does, Thucydides was wrong. We may not be doomed to repeat the Sicilian expedition: on the other hand, since we don't understand much yet about the changes that have occurred, we might be even more doomed. But at any rate, we have almost certainly changed. There *is* something new under the sun — us.

This concept opens strange doors. If true, it means that the people of Sumeria and Egypt's Old Kingdom were probably fundamentally different from us: human nature has changed — some, anyhow — over recorded history. Julian Jaynes, in *The Origin of Consciousness in the Breakdown of the Bicameral Mind,* argued that there was something qualitatively different about the human mind in ancient civilization. On first reading, *Breakdown* seemed one of the craziest books ever written, but Jaynes may have been on to something.

If people a few thousand years ago thought and acted differently because of biological differences, history is never going to be the same.

GEORGE B. DYSON
Science Historian; Author, Project Orion

Understanding molecular biology without discovering the origins of life

I predict we will reach a complete understanding of molecular biology and molecular evolution, without ever discovering the origins of life.

This idea is dangerous, because it suggests a mystery that science cannot explain. Or, it may be interpreted as confirmation that life is merely the collective result of a long series of incremental steps, and that it is impossible to draw a precise distinction between life and non-

life.

"The only thing of which I am sure," argued Samuel Butler in 1880, "is that the distinction between the organic and inorganic is arbitrary; that it is more coherent with our other ideas, and therefore more acceptable, to start with every molecule as a living thing, and then deduce death as the breaking up of an association or corporation, than to start with inanimate molecules and smuggle life into them. "

Every molecule a living thing? That's not even dangerous, it's wrong! But where else can you draw the line?

KEITH DEVLIN
Mathematician; Executive Director, Center for the Study of Language and Information, Stanford; Author, The Millennium Problems

We are entirely alone

Living creatures capable of reflecting on their own existence are a one-off, freak accident, existing for one brief moment in the history of the universe. There may be life elsewhere in the universe, but it does not have self-reflective consciousness. There is no God; no Intelligent Designer; no higher purpose to our lives.

Personally, I have never found this possibility particularly troubling, but my experience has been that most people go to considerable lengths to convince themselves that it is otherwise.

I think that many people find the suggestion dangerous because they see it as leading to a life devoid of meaning or moral values. They see it as a suggestion full of despair, an idea that makes our lives seem pointless. I believe that the opposite is the case. As the product of that unique, freak accident, finding ourselves able to reflect on and enjoy our conscious existence, the very unlikeliness and uniqueness of our situation surely makes us highly appreciative of what we have.

Life is not just important to us; it is literally everything we have. That makes it, in human terms, the most precious thing there is. That not only gives life meaning *for us*, something to be respected and revered, but a strong moral code follows automatically.

The fact that our existence has no purpose outside that existence is completely irrelevant to the way we live our lives, since we are *inside* our existence. The fact that our existence has no purpose *for the universe* — whatever that means — in no way means it has no purpose *for us*. We must ask and answer questions about ourselves *within the framework of our existence as what we are.*

FRANK TIPLER
Professor of Mathematical Physics, Tulane University; Author, The Physics of Immortality

Why I Hope the Standard Model is Wrong about Why There is More Matter Than Antimatter

The Standard Model of particle physics — a theory of all forces and particles except gravity and a theory that has survived all tests over the past thirty years — says it is possible to convert matter entirely into energy. Old-fashioned nuclear physics allows some matter to be converted into energy, but because nuclear physics requires the number of heavy particles like neutrons and protons, and light particles like electrons, to be separately conserved in nuclear reactions, only a small fraction (less than 1%) of the mass of the uranium or plutonium in an atomic bomb can be converted into energy. The Standard Model says that there is a way to convert all the mass of ordinary matter into energy; for example, it is in principle possible to convert the proton and electron making up a hydrogen atom entirely into energy. Particle physicists have long known about this possibility, but have considered it forever irrelevant to human technology because the energy required to convert matter into pure energy via this process is at the very limit of our most powerful accelerators (a trillion electron volts, or one TeV).

I am very much afraid that the particle physicists are wrong about this Standard Model pure energy conversion process being forever irrelevant to human affairs. I have recently come to believe that the consistency of quantum field theory requires that it should be possible to convert up to 100 kilograms of ordinary matter into pure energy via this process using a device that could fit inside the trunk of a car, a device that could be manufactured in a small factory. Such a device would solve all our energy problems — we would not need fossil fuels — but 100 kilograms of energy is the energy released by a 1,000-megaton nuclear bomb. If such a bomb can be manufactured in a small factory, then terrorists everywhere will eventually have such weapons. I fear for the human race if this comes to pass. I very hope I am wrong about the technological feasibility of such a bomb.

SCOTT SAMPSON
Chief Curator, Utah Museum of Natural History; Associate Professor Department of Geology and Geophysics, University of Utah; Host, Dinosaur Planet TV series

The purpose of life is to disperse energy

The truly dangerous ideas in science tend to be those that threaten the collective ego of humanity and knock us further off our pedestal of centrality. The Copernican Revolution abruptly dislodged humans from the center of the universe. The Darwinian Revolution yanked *Homo sapiens* from the pinnacle of life. Today another menacing revolution sits at the horizon of knowledge, patiently awaiting broad realization by the same egotistical species.

The dangerous idea is this: the purpose of life is to disperse energy.

Many of us are at least somewhat familiar with the second law of thermodynamics, the unwavering propensity of energy to disperse and, in doing so, transition from high quality to low quality forms. More generally, as stated by ecologist Eric Schneider, "nature abhors a gradient," where a gradient is simply a difference over a distance — for example, in temperature or pressure. Open physical systems — including those of the atmosphere, hydrosphere, and geosphere — all embody this law, being driven by the dispersal of energy, particularly the flow of heat, continually attempting to achieve equilibrium. Phenomena as diverse as lithospheric plate motions, the northward flow of the Gulf Stream, and occurrence of deadly hurricanes are all examples of second law manifestations.

There is growing evidence that life, the biosphere, is no different. It has often been said the life's complexity contravenes the second law, indicating the work either of a deity or some unknown natural process, depending on one's bias. Yet the evolution of life and the dynamics of ecosystems obey the second law mandate, functioning in large part to dissipate energy. They do so not by burning brightly and disappearing, like a fire torching a forest, but through stable metabolic cycles that store chemical energy and continually reduce the solar gradient. Photosynthetic plants, bacteria, and algae capture energy from the sun and form the core of all food webs.

Virtually all organisms, including humans, are, in a real sense, sunlight transmogrified, temporary waypoints in the flow of energy. Ecological succession, viewed from a thermodynamic perspective, is a process that maximizes the capture and degradation of energy. Similarly, the tendency for life to become more complex over the past 3.5 billion years (as well as the overall increase in biomass and organismal diversity through time) is not due simply to natural selection, as most evolutionists still argue, but also to nature's "efforts" to grab more and more of the sun's flow. The slow burn that characterizes life enables ecological systems to persist over deep time, changing in response to external and internal perturbations.

Ecology has been summarized by the pithy statement, "energy flows, matter cycles. " Yet this maxim applies equally to complex systems in the non-living world; indeed it literally unites the biosphere with the physical realm. More and more, it appears that complex, cycling, swirling systems of matter have a natural tendency to emerge in the face of energy gradients. This recurrent phenomenon may even have been the driving force behind life's origins.

This idea is not new, and is certainly not mine. Nobel laureate Erwin Schrödinger was one of

the first to articulate the hypothesis, as part of his famous "What is Life" lectures in Dublin in 1943. More recently, Jeffrey Wicken, Harold Morowitz, Eric Schneider and others have taken this concept considerably further, buoyed by results from a range of studies, particularly within ecology. Schneider and Dorian Sagan provide an excellent summary of this hypothesis in their recent book, "Into the Cool".

The concept of life as energy flow, once fully digested, is profound. Just as Darwin fundamentally connected humans to the non-human world, a thermodynamic perspective connects life inextricably to the non-living world. This dangerous idea, once broadly distributed and understood, is likely to provoke reaction from many sectors, including religion and science. The wondrous diversity and complexity of life through time, far from being the product of intelligent design, is a natural phenomenon intimately linked to the physical realm of energy flow.

Moreover, evolution is not driven by the machinations of selfish genes propagating themselves through countless millennia. Rather, ecology and evolution together operate as a highly successful, extremely persistent means of reducing the gradient generated by our nearest star. In my view, evolutionary theory (the process, not the fact of evolution!) and biology generally are headed for a major overhaul once investigators fully comprehend the notion that the complex systems of earth, air, water, and life are not only interconnected, but interdependent, cycling matter in order to maintain the flow of energy.

Although this statement addresses only naturalistic function and is mute with regard to spiritual meaning, it is likely to have deep effects outside of science. In particular, broad understanding of life's role in dispersing energy has great potential to help humans reconnect both to nature and to planet's physical systems at a key moment in our species' history.

JEREMY BERNSTEIN
Professor of Physics, Stevens Institute of Technology; Author, Hitler's Uranium Club

The idea that we understand plutonium

The most dangerous idea I have come across recently is the idea that we understand plutonium. Plutonium is the most complex element in the periodic table. It has six different crystal phases between room temperature and its melting point. It can catch fire spontaneously in the presence of water vapor and if you inhale minuscule amounts you will die of lung cancer. It is the principle element in the "pits" that are the explosive cores of nuclear weapons. In these pits it is alloyed with gallium. No one knows why this works and no one can be sure how stable this alloy is. These pits, in the thousands, are now decades old. What is dangerous is the idea that they have retained their integrity and can be safely stored into the indefinite future.

MIHALYI CSIKSZENTMIHALYI
Psychologist; Director, Quality of Life Research Center, Claremont Graduate University; Author, Flow

The free market

Generally ideas are thought to be dangerous when they threaten an entrenched authority. Galileo was sued not because he claimed that the earth revolved around the sun — a "hypothesis" his chief prosecutor, Cardinal Bellarmine, apparently was quite willing to entertain in private — but because the Church could not afford a fact it claimed to know be reversed by another epistemology, in this case by the scientific method. Similar conflicts arose when Darwin's view of how humans first appeared on the planet challenged religious accounts of creation, or when Mendelian genetics applied to the growth of hardier strains of wheat challenged Leninist doctrine as interpreted by Lysenko.

One of the most dangerous ideas at large in the current culture is that the "free market" is the ultimate arbiter of political decisions, and that there is an "invisible hand" that will direct us to the most desirable future provided the free market is allowed to actualize itself. This mystical faith is based on some reasonable empirical foundations, but when embraced as a final solution to the ills of humankind, it risks destroying both the material resources, and the cultural achievements that our species has so painstakingly developed.

So the dangerous idea on which our culture is based is that the political economy has a silver bullet — the free market — that must take precedence over any other value, and thereby lead to peace and prosperity. It is dangerous because like all silver bullets it is an intellectual and political scam that might benefit some, but ultimately requires the majority to pay for the destruction it causes.

My dangerous idea is dangerous only to those who support the hegemony of the market. It consists in pointing out that the imperial free market wears no clothes — it does not exist in the first place, and what passes for it is dangerous to the future well being of our species. Scientist need to turn their attention to what the complex system that is human life, will require in the future.

Beginnings like the Calvert-Henderson *Quality of Life Indicators*, which focus on such central requirements as health, education, infrastructure, environment, human rights, and public safety, need to become part of our social and political agenda. And when their findings come into conflict with the agenda of the prophets of the free market, the conflict should be examined — who is it that benefits from the erosion of the quality of life?

IRENE PEPPERBERG
Research Associate, Psychology, Harvard University; Author, The Alex Studies

The differences between humans and nonhumans are quantitative, not qualitative

I believe that the differences between humans and nonhumans are quantitative, not qualitative.

Why is this idea dangerous? It is hardly surprising, coming from someone who has spent her scientific career studying the abilities of (supposedly) small-brained nonhumans; moreover, the idea is not exactly new. It may be a bit controversial, given that many of my colleagues spend much of their time searching for the defining difference that separates humans and nonhumans (and they may be correct), and also given a current social and political climate that challenges evolution on what seems to be a daily basis. But why dangerous? Because, if we take this idea to its logical conclusion, it challenges almost every aspect of our lives — scientific and nonscientific alike.

Scientifically, the idea challenges the views of many researchers who continue to hypothesize about the next human-nonhuman 'great divide'…Interestingly, however, detailed observation and careful experimentation have repeatedly demonstrated that nonhumans often possess capacities once thought to separate them from humans. Humans, for example, are not the only tool-using species, nor the only tool-making species, nor the only species to act cooperatively.

So one has to wonder to what degree nonhumans share other capacities still thought to be exclusively human. And, of course, the critical words here are "to what degree" — do we count lack of a particular behavior a defining criterion, or do we accept the existence of less complex versions of that behavior as evidence for a continuum? If one wishes to argue that I'm just blurring the difference between "qualitative" and "quantitative", so be it…such blurring will not affect the dangerousness of my idea.

My idea is dangerous because it challenges scientists at a more basic level, that of how we *perform* research. Now, let me state clearly that I'm not against animal research — I wouldn't be alive today without it, and I work daily with captive animals that, although domestically bred (and that, by any standard, are provided with a fairly cushy existence), are still essentially wild creatures denied their freedom.

But if we believe in a continuum, then we must at least question our right to perform experiments on our fellow creatures; we need to think about how to limit animal experiments and testing to what is essential, and to insist on humane (note the term!) housing and treatment. And, importantly, we must accept the significant cost in time, effort, and money thereby incurred — increases that must come at the expense of something else in our society.

The idea, taken to its logical conclusion, is dangerous because it should also affect our choices as to the origins of the clothes we wear and the foods we eat. Again, I'm not campaigning against leather shoes and T-bone steaks; I find that I personally cannot remain healthy on a totally vegetarian diet and sheepskin boots definitely ease the rigors of a Massachusetts winter.

But if we believe in a continuum, we must at least question our right to use fellow creatures for our sustenance: We need to become aware of, for example, the conditions under which creatures destined for the slaughterhouse live their lives, and learn about and ameliorate the conditions in which their lives are ended. And, again, we must accept the costs involved in such decisions.

If we do not believe in a clear boundary between humans and nonhumans, if we do not accept a clear "them" versus "us", we need to rethink other aspects of our lives. Do we have the right to clear-cut forests in which our fellow creatures live? To pollute the air, soil and water that we share with them, solely for our own benefit? Where do we draw the line? Life may be much simpler if we do firmly draw a line, but is simplicity a valid rationale?

And, in case anyone wonders at my own personal view: I believe that humans are the ultimate generalists, creatures that may lack specific talents or physical adaptations that have been finely honed in other species, but whose additional brain power enables them — in an exquisite manner — to, for example, integrate information, improvise with what is present, and alter or adapt to a wide range of environments…but that this additional brain power is (and provides) a quantitative, not qualitative difference.

BRIAN GOODWIN
Biologist, Schumacher College, Devon, UK; Author, How The Leopard Changed Its Spots

Fields of Danger

In science, the concept of a field is used to describe patterns of order in systems that are extended in space and show regularities of behaviour in time. They have always expressed ideas that are rather mysterious, but work in describing natural processes. The first example of a field principle in physics was Newton's celebrated gravitational law, which described mathematically the universal attraction between bodies with mass.

This mysterious action at a distance without any wires or mechanical attachments between the bodies was regarded as a mystical, occult concept by the mechanical philosophers of the 17th and 18th centuries. They condemned Newton's idea as a violation of the principles of explanation in the new science. However, there is a healthy pragmatic element to scientific investigation, and Newton's equations worked too well to be discarded on philosophical

grounds.

Another celebrated example of a physical field came from the experimental work of Michael Faraday on electricity and magnetism in the 19th century. He talked about fields of force that extend out in space from electrically charged bodies, or from magnets. Faraday's painstaking and ingenious work described how these fields change with distance from the body in precise ways, as does the gravitational force. Again these forces were regarded as mysterious since they travel through apparently empty space, exerting interaction at a distance that cannot be understood mechanically.

However, so precise were Faraday's measurements of the properties of electric and magnetic fields, and so vivid his description of the fields of force associated with them, that James Clerk Maxwell could take his observations and put them directly into mathematical form. These are the famous wave equations of electromagnetism on which our technology for electric motors, lighting, TV, communications and innumerable other applications is based.

In the 20th century with Einstein transformed Newton's mysterious gravitational force into an even more mysterious property of space itself: it bends or curves under the influence of bodies with mass. Einstein's relativity theory did away with a force of attraction between bodies and substituted a mathematical relationship between mass and curvature of space-time.

The result was a whole new way of understanding motion as natural, curved paths followed by bodies that not only cause the curvature but follow it. The universe was becoming intrinsically self-organising and subjects as observers made an entry into physics.

As if Einstein's relativity wasn't enough to shake up the world known to science, the next revolution was even more disturbing. Quantum mechanics, emerging in the 1920s, did away with the classical notions of fields as smooth distributions of forces through space-time and described interactions at a distance in terms of discrete little packets of energy that travel through the void in oscillating patterns described by wave functions, of which the solutions to Schrödinger's wave equation are the best known.

Now we have not only action at a distance but something infinitely more disturbing: these interactions violate conventional notions of causality because they are non-local. Two particles that have been joined in an intimate relationship within an atom remain coherently correlated with one another in their properties no matter how far apart they may be after emission from the atom. Einstein could not bring himself to believe that this 'spooky' implication of quantum mechanics could possibly be real.

The implied entanglement means that there is a holistic principle of connectedness in operation at the most elementary level of physical reality. Quantum fields have subverted our basic notions of causality and substituted a principle of wholeness in relationship for elementary particles.

The idea that I have pursued in biology for much of my career is the concept that goes under the name of a morphogenetic field. This term is used to describe the processes in space and

time that organise and coordinate the various activities involved in the emergence of a whole complex organism from a single cell, or from a group of cells in interaction with each another.

A human embryo developing in the mother's womb from a single fertilised egg, emerging at birth as a baby with all its organs coherently arranged in a functioning body, is one of the most breathtaking phenomena in nature. However, all species share the same ability to produce new individuals of the same kind in their processes of reproduction.

The remarkable organising principles that underlie such basic properties of life have been known as morphogenetic fields (fields that generate form) throughout the 20th century, though this concept produces unease and discomfort among many biologists.This unease arises for good reason. As in physics, the field concept is subversive of mechanical explanations in science, and biology holds firmly to understanding life in terms of mechanisms organised by genes.

However, the complete reading of the book of life in DNA, the major project in biology during the last two decades of the 20th century, did not reveal the secrets of the organism. It was a remarkable achievement to work out the sequence of letters in the genomes of different species, human, other animals, plants, and microbes, so that many of the words of the genetic text of different species could be deciphered.

Unfortunately, we were unable to make coherent sense of these words, to put them together in the way that organisms do in creating themselves during their reproduction as they develop into beings with specific morphologies and behaviours, the process of morphogenesis. What had been forgotten, or ignored, was that information only makes sense to an agent, someone or something with the know-how to interpret it.

The meaning was missing because the genome researchers ignored the context of the genomes: the living cell within which genes are read and their products are organised. The organisation that is responsible for making sense of the information in the genes, an essential and basic aspect of the living state, was taken for granted. What is the nature of this complex dynamic process that knows how to make an organism, using specific information from the genes?

Biology is returning to notions of space-time organisation as an intrinsic aspect of the living condition, our old friends morphogenetic fields. They are now described as complex networks of molecules that somehow read and make sense of genes. These molecular networks have intriguing properties, giving them some of the same characteristics as words in a language.

Could it be that biology and culture are not so different after all; that both are based on historical traditions and languages that are used to construct patterns of relationship embodied in communities, either of cells or of individuals? These self-organising activities are certainly mysterious, but not unintelligible. My own work, with many colleagues, cast morphogenetic fields in mathematical form that revealed how space (morphology) and time (behaviour) get organised in subtle but robust ways in developing organisms and communities.

Such coordinating patterns in living beings seem to be at the heart of the creativity that drives both biological and cultural evolution. Despite many differences between these fields, which need to be clarified and distinguished rather than blurred, there may be underlying commonalities that can unify biological and cultural evolution rather than separating them.

This could even lead us to value other species of organism for their wisdom in achieving coherent, sustainable relationships with other species while remaining creative and innovative throughout evolution, something we are signally failing to do in our culture with its ecologically damaging style of living.

RUDY RUCKER

Mathematician, Computer Scientist; CyberPunk Pioneer; Novelist; Author, Lifebox, the Seashell, and the Soul

Mind is a universally distributed quality

Panpsychism. Each object has a mind. Stars, hills, chairs, rocks, scraps of paper, flakes of skin, molecules — each of them possesses the same inner glow as a human, each of them has singular inner experiences and sensations.

I'm quite comfortable with the notion that everything is a computation. But what to do about my sense that there's something numinous about my inner experience? Panpsychism represents a non-anthropocentric way out: mind is a universally distributed quality.

Yes, the workings of a human brain are a deterministic computation that could be emulated by any universal computer. And, yes, I sense more to my mental phenomena than the rule-bound exfoliation of reactions to inputs: this residue is the inner light, the raw sensation of existence. But, no, that inner glow is not the exclusive birthright of humans, nor is it solely limited to biological organisms.

Note that panpsychism needn't say that universe is just one mind. We can also say that each object has an individual mind. One way to visualize the distinction between the many minds and the one mind is to think of the world as a stained glass window with light shining through each pane. The world's physical structures break the undivided cosmic mind into a myriad of small minds, one in each object.

The minds of panpsychism can exist at various levels. As well as having its own individuality, a person's mind would also be, for instance, a hive mind based upon the minds of the body's cells and the minds of the body's elementary particles.

Do the panpsychic minds have any physical correlates? On the one hand, it could be that the mind is some substance that accumulates near ordinary matter — dark matter or dark energy are good candidates. On the other hand, mind might simply be matter viewed in a special fashion: matter experienced from the inside. Let me mention three specific physical correlates that have been proposed for the mind.

Some have argued that the experience of mind results when a superposed quantum state collapses into a pure state. It's an alluring metaphor, but as a universal automatist, I'm of the opinion that quantum mechanics is a stop-gap theory, destined to give way to a fully deterministic theory based upon some digital precursor of spacetime.

David Skrbina, author of the clear and comprehensive book *Panpsychism in the West*, suggests that we might think of a physical system as determining a moving point in a multi-dimensional phase space that has an axis for each of the system's measurable properties. He feels this dynamic point represents the sense of unity characteristic of a mind.

As a variation on this theme, let me point out that, from the universal automatist standpoint, every physical system can be thought of as embodying a computation. And the majority of non-simple systems embody universal computations, capable of emulating any other system at all. It could be that having a mind is in some sense equivalent to being capable of universal computation.

A side-remark. Even such very simple systems as a single electron may in fact be capable of universal computation, if supplied with a steady stream of structured input. Think of an electron in an oscillating field; and by analogy think of a person listening to music or reading an essay.

Might panpsychism be a distinction without a difference? Suppose we identify the numinous mind with quantum collapse, with chaotic dynamics, or with universal computation. What is added by claiming that these aspects of reality are like minds?

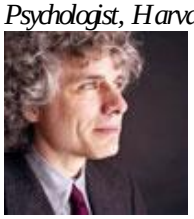
I think empathy can supply an experiential confirmation of panpsychism's reality. Just as I'm sure that I myself have a mind, I can come to believe the same of another human with whom I'm in contact — whether face to face or via their creative work. And with a bit of effort, I can identify with objects as well; I can see the objects in the room around me as glowing with inner light. This is a pleasant sensation; one feels less alone.

Could there ever be a critical experiment to test if panpsychism is really true? Suppose that telepathy were to become possible, perhaps by entangling a person's mental states with another system's states. And then suppose that instead of telepathically contacting another person, I were to contact a rock. At this point panpsychism would be proved.

I still haven't said anything about why panpsychism is a dangerous idea. Panpsychism, like other forms of higher consciousness, is dangerous to business as usual. If my old car has the same kind of mind as a new one, I'm less impelled to help the economy by buying a new vehicle. If the rocks and plants on my property have minds, I feel more respect for them in

their natural state. If I feel myself among friends in the universe, I'm less likely to overwork myself to earn more cash. If my body will have a mind even after I'm dead, then death matters less to me, and it's harder for the government to cow me into submission.

STEVEN PINKER
Psychologist, Harvard University; Author, The Blank Slate



Groups of people may differ genetically in their average talents and temperaments

The year 2005 saw several public appearances of what will I predict will become the dangerous idea of the next decade: that groups of people may differ genetically in their average talents and temperaments.

- In January, Harvard president Larry Summers caused a firestorm when he cited research showing that women and men have non-identical statistical distributions of cognitive abilities and life priorities.

- In March, developmental biologist Armand Leroi published an op-ed in the *New York Times* rebutting the conventional wisdom that race does not exist. (The conventional wisdom is coming to be known as Lewontin's Fallacy: that because most genes may be found in all human groups, the groups don't differ at all. But patterns of *correlation* among genes do differ between groups, and different clusters of correlated genes correspond well to the major races labeled by common sense.)

- In June, the *Times* reported a forthcoming study by physicist Greg Cochran, anthropologist Jason Hardy, and population geneticist Henry Harpending proposing that Ashkenazi Jews have been biologically selected for high intelligence, and that their well-documented genetic diseases are a by-product of this evolutionary history.

- In September, political scientist Charles Murray published an article in *Commentary* reiterating his argument from *The Bell Curve* that average racial differences in intelligence are intractable and partly genetic.

Whether or not these hypotheses hold up (the evidence for gender differences is reasonably good, for ethnic and racial differences much less so), they are widely perceived to be dangerous. Summers was subjected to months of vilification, and proponents of ethnic and racial differences in the past have been targets of censorship, violence, and comparisons to Nazis. Large swaths of the intellectual landscape have been reengineered to try to rule these hypotheses out a priori (race does not exist, intelligence does not exist, the mind is a blank slate inscribed by parents). The underlying fear, that reports of group differences will fuel

bigotry, is not, of course, groundless.

The intellectual tools to defuse the danger are available. "Is" does not imply "ought. " Group differences, when they exist, pertain to the average or variance of a statistical distribution, rather than to individual men and women. Political equality is a commitment to universal human rights, and to policies that treat people as individuals rather than representatives of groups; it is not an empirical claim that all groups are indistinguishable. Yet many commentators seem unwilling to grasp these points, to say nothing of the wider world community.

Advances in genetics and genomics will soon provide the ability to test hypotheses about group differences rigorously. Perhaps geneticists will forbear performing these tests, but one shouldn't count on it. The tests could very well emerge as by-products of research in biomedicine, genealogy, and deep history which no one wants to stop.

The human genomic revolution has spawned an enormous amount of commentary about the possible perils of cloning and human genetic enhancement. I suspect that these are red herrings. When people realize that cloning is just forgoing a genetically mixed child for a twin of one parent, and is not the resurrection of the soul or a source of replacement organs, no one will want to do it. Likewise, when they realize that most genes have costs as well as benefits (they may raise a child's IQ but also predispose him to genetic disease), "designer babies" will lose whatever appeal they have. But the prospect of genetic tests of group differences in psychological traits is both more likely and more incendiary, and is one that the current intellectual community is ill-equipped to deal with.

RICHARD E. NISBETT
Professor of Psychology, Co-Director of the Culture and Cognition Program, University of Michigan; Author, The Geography of Thought: How Asians and Westerners Think Differently. . . And Why

Telling More Than We Can Know

Do you know why you hired your most recent employee over the runner-up? Do you know why you bought your last pair of pajamas? Do you know what makes you happy and unhappy?

Don't be too sure. The most important thing that social psychologists have discovered over the last 50 years is that people are very unreliable informants about why they behaved as they did, made the judgment they did, or liked or disliked something. In short, we don't know nearly as much about what goes on in our heads as we think. In fact, for a shocking range of things, we don't know the answer to "Why did I?" any better than an observer.

The first inkling that social psychologists had about just how ignorant we are about our thinking processes came from the study of cognitive dissonance beginning in the late 1950s. When our behavior is insufficiently justified, we move our beliefs into line with the behavior so as to avoid the cognitive dissonance we would otherwise experience. But we are usually quite unaware that we have done that, and when it is pointed out to us we recruit phantom reasons for the change in attitude.

Beginning in the mid-1960s, social psychologists started doing experiments about the causal attributions people make for their own behavior. If you give people electric shocks, but tell them that you have given them a pill that will produce the arousal symptoms that are actually created by the shock, they will take much more shock than subjects without the pill. They have attributed their arousal to the pill and are therefore willing to take more shock. But if you ask them why they took so much shock they are likely to say something like "I used to work with electrical gadgets and I got a lot of shocks, so I guess I got used to it."

In the 1970s social psychologists began asking whether people could be accurate about why they make truly simple judgments and decisions — such as why they like a person or an article of clothing.

For example, in one study experimenters videotaped a Belgian responding in one of two modes to questions about his philosophy as a teacher: he either came across as an ogre or a saint. They then showed subjects one of the two tapes and asked them how much they liked the teacher. Furthermore, they asked some of them whether the teacher's accent had affected how much they liked him and asked others whether how much they liked the teacher influenced how much they liked his accent. Subjects who saw the ogre naturally disliked him a great deal, and they were quite sure that his grating accent was one of the reasons. Subjects who saw the saint realized that one of the reasons they were so fond of him was his charming accent. Subjects who were asked if their liking for the teacher could have influenced their judgment of his accent were insulted by the question.

Does familiarity breed contempt? On the contrary, it breeds liking. In the 1980s, social psychologists began showing people such stimuli as Turkish words and Chinese ideographs and asking them how much they liked them. They would show a given stimulus somewhere between one and twenty-five times. The more the subjects saw the stimulus the more they liked it. Needless to say, their subjects did not find it plausible that the mere number of times they had seen a stimulus could have affected their liking for it. (You're probably wondering if white rats are susceptible to the mere familiarity effect.

The study has been done. Rats brought up listening to music by Mozart prefer to move to the side of the cage that trips a switch allowing them to listen to Mozart rather than Schoenberg. Rats raised on Schoenberg prefer to be on the Schoenberg side. The rats were not asked the reasons for their musical preferences.)

Does it matter that we often don't know what goes on in our heads and yet believe that we do? Well, for starters, it means that we often can't answer accurately crucial questions about what makes us happy and what makes us unhappy. A social psychologist asked Harvard

women to keep a daily record for two months of their mood states and also to record a number of potentially relevant factors in their lives including amount of sleep the night before, the weather, general state of health, sexual activity, and day of the week (Monday blues? TGIF?). At the end of the period, subjects were asked to tell the experimenters how much each of these factors tended to influence their mood over the two month period. The results? Women's reports of what influenced their moods were uncorrelated with what they had reported on a daily basis. If a woman thought that her sexual activity had a big effect, a check of her daily reports was just as likely to show that it had no effect as that it did. To really rub it in, the psychologist asked her subjects to report what influenced the moods of someone they didn't know: She found that accuracy was just as great when a woman was rated by a stranger as when rated by the woman herself!

But if we were to just think really hard about reasons for behavior and preferences might we be likely to come to the right conclusions?

Actually, just the opposite may often be the case. A social psychologist asked people to choose which of several art posters they liked best.

Some people were asked to analyze why they liked or disliked the various posters and some were not asked, and everyone was given their favorite poster to take home. Two weeks later the psychologist called people up and asked them how much they liked the art poster they had chosen. Those who did not analyze their reasons liked their posters better than those who did.

It's certainly scary to think that we're ignorant of so much of what goes on in our heads, though we're almost surely better off taking with a large quantity of salt what we and others say about motives and reasons. Skepticism about our ability to read our minds is safer than certainty that we can.

Still, the idea that we have little access to the workings of our minds is a dangerous one. The theories of Copernicus and Darwin were dangerous because they threatened, respectively, religious conceptions of the centrality of humans in the cosmos and the divinity of humans.

Social psychologists are threatening a core conviction of the Enlightenment — that humans are perfectible through the exercise of reason. If reason cannot be counted on to reveal the causes of our beliefs, behavior and preferences, then the idea of human perfectibility is to that degree diminished.

ROBERT R. PROVINE
Psychologist and Neuroscientist, University of Maryland; Author, Laughter

This is all there is

The empirically testable idea that the here and now is all there is and that life begins at birth and ends at death is so dangerous that it has cost the lives of millions and threatens the future of civilization. The danger comes not from the idea itself, but from its opponents, those religious leaders and followers who ruthlessly advocate and defend their empirically improbable afterlife and man-in-the-sky cosmological perspectives.

Their vigor is understandable. What better theological franchise is there than the promise of everlasting life, with deluxe trimmings? Religious followers must invest now with their blood and sweat, with their big payoff not due until the after-life. Postmortal rewards cost theologians nothing--I'll match your heavenly choir and raise you 72 virgins.

Some franchise! This is even better than the medical profession, a calling with higher overhead, that has gained control of birth, death and pain. Whether the religious brand is Christianity or Islam, the warring continues, with a terrible fate reserved for heretics who threaten the franchise from within. Worse may be in store for those who totally reject the man-in-the-sky premise and its afterlife trappings. All of this trouble over accepting what our senses tell us—that this is all there is.

Resolution of religious conflict is impossible because there is no empirical test of the ghostly, and many theologians prey, intentionally or not, upon the fears, superstitions, irrationality, and herd tendencies that are our species' neurobehavioral endowment. Religious fundamentalism inflames conflict and prevents solution—the more extreme and irrational one's position, the stronger one's faith, and, when possessing absolute truth, compromise is not an option.

Resolution of conflicts between religions and associated cultures is less likely to come from compromise than from the pursuit of superordinate goals, common, overarching, objectives that extend across nations and cultures, and direct our competitive spirit to further the health, well-being, and nobility of everyone. Public health and science provide such unifying goals. I offer two examples.

Health Initiative. A program that improves the health of all people, especially those in developing nations, may find broad support, especially with the growing awareness of global culture and the looming specter of a pandemic. Public health programs bridge religious, political, and cultural divides. No one wants to see their children die. Conflicts fall away when cooperation offers a better life for all concerned. This is also the most effective anti-terrorism strategy, although one probably unpopular with the military industrial complex on one side, and terrorist agitators on the other.

Space Initiative. Space exploration expands our cosmos and increases our appreciation of life on Earth and its finite resources. Space exploration is one of our species' greatest achievements. Its pursuit is a goal of sufficient grandeur to unite people of all nations.

This is all there is. The sooner we accept this dangerous idea, the sooner we can get on with the essential task of making the most of our lives on this planet.

DONALD HOFFMAN
Cognitive Scientist, UC, Irvine; Author, Visual Intelligence

A spoon is like a headache

A spoon is like a headache. This is a dangerous idea in sheep's clothing. It consumes decrepit ontology, preserves methodological naturalism, and inspires exploration for a new ontology, a vehicle sufficiently robust to sustain the next leg of our search for a theory of everything.

How could a spoon and a headache do all this? Suppose I have a headache, and I tell you about it. It is, say, a pounding headache that started at the back of the neck and migrated to encompass my forehead and eyes. You respond empathetically, recalling a similar headache you had, and suggest a couple remedies. We discuss our headaches and remedies a bit, then move on to other topics.

Of course no one but me can experience my headaches, and no one but you can experience yours. But this posed no obstacle to our meaningful conversation. You simply assumed that my headaches are relevantly similar to yours, and I assumed the same about your headaches. The fact that there is no "public headache," no single headache that we both experience, is simply no problem.

A spoon is like a headache. Suppose I hand you a spoon. It is common to assume that the spoon I experience during this transfer is numerically identical to the spoon you experience. But this assumption is false. No one but me can experience my spoon, and no one but you can experience your spoon. But this is no problem. It is enough for me to assume that your spoon experience is relevantly similar to mine. For effective communication, no public spoon is necessary, just like no public headache is necessary. Is there a "real spoon," a mind-independent physical object that causes our spoon experiences and resembles our spoon experiences? This is not only unnecessary but unlikely. It is unlikely that the visual experiences of homo sapiens, shaped to permit survival in a particular range of niches, should miraculously also happen to resemble the true nature of a mind-independent realm. Selective pressures for survival do not, except by accident, lead to truth.

One can have a kind of objectivity without requiring public objects. In special relativity, the measurements, and thus the experiences, of mass, length and time differ from observer to observer, depending on their relative velocities. But these differing experiences can be related by the Lorentz transformation. This is all the objectivity one can have, and all one needs to do science.

Once one abandons public physical objects, one must reformulate many current open

problems in science. One example is the mind-brain relation. There are no public brains, only my brain experiences and your brain experiences. These brain experiences are just the simplified visual experiences of homo sapiens, shaped for survival in certain niches. The chances that our brain experiences resemble some mind-independent truth are remote at best, and those who would claim otherwise must surely explain the miracle. Failing a clever explanation of this miracle, there is no reason to believe brains cause anything, including minds. And here the wolf unzips the sheep skin, and darts out into the open. The danger becomes apparent the moment we switch from boons to sprains. Oh, pardon the spoonerism.

MARC D. HAUSER
Psychologist and Biologist, Harvard University: Author, Wild Minds

A universal grammar of [mental] life

The recent explosion of work in molecular evolution and developmental biology has, for the first time, made it possible to propose a radical new theory of mental life that if true, will forever rewrite the textbooks and our way of thinking about our past and future. It explains both the universality of our thoughts as well as the unique signatures that demarcate each human culture, past, present and future.

The theory I propose is that human mental life is based on a few simple, abstract, yet expressively powerful rules or computations together with an instructive learning mechanism that prunes the range of possible systems of language, music, mathematics, art, and morality to a limited set of culturally expressed variants. In many ways, this view isn't new or radical. It stems from thinking about the seemingly constrained ways in which relatively open ended or generative systems of expression create both universal structure and limited variation.

Unfortunately, what appears to be a rather modest proposal on some counts, is dangerous on another. It is dangerous to those who abhor biologically grounded theories on the often misinterpreted perspective that biology determines our fate, derails free will, and erases the soul. But a look at systems other than the human mind makes it transparently clear that the argument from biological endowment does not entail any of these false inferences.

For example, we now understand that our immune systems don't learn from the environment how to tune up to the relevant problems. Rather, we are equipped with a full repertoire of antibodies to deal with a virtually limitless variety of problems, including some that have not yet even emerged in the history of life on earth. This initially seems counter-intuitive: how could the immune system have evolved to predict the kinds of problems we might face? The answer is that it couldn't.

What it evolved instead was a set of molecular computations that, in combination with each other, can handle an infinitely larger set of conditions than any single combination on its own. The role of the environment is as instructor, functionally telling the immune system about the current conditions, resulting in a process of pairing down of initial starting options.

The pattern of change observed in the immune system, characterized by an initial set of universal computations or options followed by an instructive process of pruning, is seen in systems as disparate as the genetic mechanisms underlying segmented body parts in vertebrates, the basic body plan of land plants involving the shoot system of stem and leaves, and song development in birds. Songbirds are particularly interesting as the system for generating a song seems to be analogous in important ways to our capacity to generate a specific language. Humans and songbirds start with a species-specific capacity to build language and song respectively, and this capacity has limitless expressive power. Upon delivery and hatching, and possibly a bit before, the local acoustic environment begins the process of instruction, pruning the possible languages and songs down to one or possibly two. The common thread here is a starting state of universal computations or options followed by an instructive process of pruning, ending up with distinctive systems that share an underlying common core. Hard to see how anyone could find this proposal dangerous or off-putting, or even wrong!

Now jump laterally, and make the move to aesthetics and ethics. Our minds are endowed with universal computations for creating and judging art, music, and morally relevant actions. Depending upon where we are born, we will find atonal music pleasing or disgusting, and infanticide obligatory or abhorrent. The common or universal core is, for music, a set of rules for combining together notes to alter our emotions, and for morality, a different set of rules for combining the causes and consequences of action to alter our permissibility judgments.

To say that we are endowed with a universal moral sense is not to say that we will do the right or wrong thing, with any consistency. The idea that there is a moral faculty, grounded in our biology, says nothing at all about the good, the bad or the ugly. What it says is that we have evolved particular biases, designed as a function of selection for particular kinds of fit to the environment, under particular constraints. But nothing about this claim leads to the good or the right or the permissible.

The reason this has to be the case is twofold: there is not only cultural variation but environmental variation over evolutionary time. What is good for us today may not be good for us tomorrow. But the key insight delivered by the nativist perspective is that we must understand the nature of our biases in order to work toward some good or better world, realizing all along that we are constrained. Appreciating the choreography between universal options and instructive pruning is only dangerous if misused to argue that our evolved nature is good, and what is good is right. That's bad.

RAY KURZWEIL
Inventor and Technologist; Author, The Singularity Is Near: When Humans Transcend Biology

The near-term inevitability of radical life extension and expansion

My dangerous idea is the near-term inevitability of radical life extension and expansion. The idea is dangerous, however, only when contemplated from current linear perspectives.

First the inevitability: the power of information technologies is doubling each year, and moreover comprises areas beyond computation, most notably our knowledge of biology and of our own intelligence. It took 15 years to sequence HIV and from that perspective the genome project seemed impossible in 1990. But the amount of genetic data we were able to sequence doubled every year while the cost came down by half each year.

We finished the genome project on schedule and were able to sequence SARS in only 31 days. We are also gaining the means to reprogram the ancient information processes underlying biology. RNA interference can turn genes off by blocking the messenger RNA that express them. New forms of gene therapy are now able to place new genetic information in the right place on the right chromosome. We can create or block enzymes, the work horses of biology. We are reverse-engineering — and gaining the means to reprogram — the information processes underlying disease and aging, and this process is accelerating, doubling every year. If we think linearly, then the idea of turning off all disease and aging processes appears far off into the future just as the genome project did in 1990. On the other hand, if we factor in the doubling of the power of these technologies each year, the prospect of radical life extension is only a couple of decades away.

In addition to reprogramming biology, we will be able to go substantially beyond biology with nanotechnology in the form of computerized nanobots in the bloodstream. If the idea of programmable devices the size of blood cells performing therapeutic functions in the bloodstream sounds like far off science fiction, I would point out that we are doing this already in animals. One scientist cured type I diabetes in rats with blood cell sized devices containing 7 nanometer pores that let insulin out in a controlled fashion and that block antibodies. If we factor in the exponential advance of computation and communication (price-performance multiplying by a factor of a billion in 25 years while at the same time shrinking in size by a factor of thousands), these scenarios are highly realistic.

The apparent dangers are not real while unapparent dangers are real. The apparent dangers are that a dramatic reduction in the death rate will create over population and thereby strain energy and other resources while exacerbating environmental degradation. However we only need to capture 1 percent of 1 percent of the sunlight to meet all of our energy needs (3 percent of 1 percent by 2025) and nanoengineered solar panels and fuel cells will be able to do this, thereby meeting all of our energy needs in the late 2020s with clean and renewable methods. Molecular nanoassembly devices will be able to manufacture a wide range of

products, just about everything we need, with inexpensive tabletop devices. The power and price-performance of these systems will double each year, much faster than the doubling rate of the biological population. As a result, poverty and pollution will decline and ultimately vanish despite growth of the biological population.

There are real downsides, however, and this is not a utopian vision. We have a new existential threat today in the potential of a bioterrorist to engineer a new biological virus. We actually do have the knowledge to combat this problem (for example, new vaccine technologies and RNA interference which has been shown capable of destroying arbitrary biological viruses), but it will be a race. We will have similar issues with the feasibility of self-replicating nanotechnology in the late 2020s. Containing these perils while we harvest the promise is arguably the most important issue we face.

Some people see these prospects as dangerous because they threaten their view of what it means to be human. There is a fundamental philosophical divide here. In my view, it is not our limitations that define our humanity. Rather, we are the species that seeks and succeeds in going beyond our limitations.

HAIM HARARI
Physicist, former President, Weizmann Institute of Science

Democracy may be on its way out

Democracy may be on its way out. Future historians may determine that Democracy will have been a one-century episode. It will disappear. This is a sad, truly dangerous, but very realistic idea (or, rather, prediction).

Falling boundaries between countries, cross border commerce, merging economies, instant global flow of information and numerous other features of our modern society, all lead to multinational structures. If you extrapolate this irreversible trend, you get the entire planet becoming one political unit. But in this unit, anti-democracy forces are now a clear majority. This majority increases by the day, due to demographic patterns. All democratic nations have slow, vanishing or negative population growth, while all anti-democratic and uneducated societies multiply fast. Within democratic countries, most well-educated families remain small while the least educated families are growing fast. This means that, both at the individual level and at the national level, the more people you represent, the less economic power you have. In a knowledge based economy, in which the number of working hands is less important, this situation is much more non-democratic than in the industrial age. As long as upward mobility of individuals and nations could neutralize this phenomenon, democracy was tenable. But when we apply this analysis to the entire planet, as it evolves now, we see that democracy may

be doomed.

To these we must add the regrettable fact that authoritarian multinational corporations, by and large, are better managed than democratic nation states. Religious preaching, TV sound bites, cross boundary TV incitement and the freedom of spreading rumors and lies through the internet encourage brainwashing and lack of rational thinking. Proportionately, more young women are growing into societies which discriminate against them than into more egalitarian societies, increasing the worldwide percentage of women treated as second class citizens. Educational systems in most advanced countries are in a deep crisis while modern education in many developing countries is almost non-existent. A small well-educated technological elite is becoming the main owner of intellectual property, which is, by far, the most valuable economic asset, while the rest of the world drifts towards fanaticism of one kind or another. Add all of the above and the unavoidable conclusion is that Democracy, our least bad system of government, is on its way out.

Can we invent a better new system? Perhaps. But this cannot happen if we are not allowed to utter the sentence: "There may be a political system which is better than Democracy". Today's political correctness does not allow one to say such things. The result of this prohibition will be an inevitable return to some kind of totalitarian rule, different from that of the emperors, the colonialists or the landlords of the past, but not more just. On the other hand, open and honest thinking about this issue may lead either to a gigantic worldwide revolution in educating the poor masses, thus saving democracy, or to a careful search for a just (repeat, just) and better system.

I cannot resist a cheap parting shot: When, in the past two years, Edge asked for brilliant ideas you believe in but cannot prove, or for proposing new exciting laws, most answers related to science and technology. When the question is now about dangerous ideas, almost all answers touch on issues of politics and society and not on the "hard sciences". Perhaps science is not so dangerous, after all.

DAVID G. MYERS

Social Psychologist; Co-author (with Letha Scanzoni); What God has Joined Together: A Christian Case for Gay Marriage

A marriage option for all

Much as others have felt compelled by evidence to believe in human evolution or the warming of the planet, I feel compelled by evidence to believe a) that sexual orientation is a natural, enduring disposition and b) that the world would be a happier and healthier place if, for all people, romantic love, sex, and marriage were a package.

In my Midwestern social and religious culture, the words "for all people" transform a conservative platitude into a dangerous idea, over which we are fighting a culture war. On one side are traditionalists, who feel passionately about the need to support and renew marriage. On the other side are progressives, who assume that our sexual orientation is something we did not choose and cannot change, and that we all deserve the option of life within a covenant partnership.

I foresee a bridge across this divide as folks on both the left and the right engage the growing evidence of our panhuman longing for belonging, of the benefits of marriage, and of the biology and persistence of sexual orientation. We now have lots of data showing that marriage is conducive to healthy adults, thriving children, and flourishing communities. We also have a dozen discoveries of gay-straight differences in everything from brain physiology to skill at mentally rotating geometric figures. And we have an emerging professional consensus that sexual reorientation therapies seldom work.

More and more young adults — tomorrow's likely majority, given generational succession — are coming to understand this evidence, and to support what in the future will not seem so dangerous: a marriage option for all.

CLAY SHIRKY

Social & Technology Network Topology Researcher; Adjunct Professor, NYU Graduate School of Interactive Telecommunications Program (ITP)

Free will is going away. Time to redesign society to take that into account.

In 2002, a group of teenagers sued McDonald's for making them fat, charging, among other things, that McDonald's used promotional techniques to get them to eat more than they should. The suit was roundly condemned as an the erosion of the sense of free will and personal responsibility in our society. Less widely remarked upon was that the teenagers were offering an accurate account of human behavior.

Consider the phenomenon of 'super-sizing', where a restaurant patron is offered the chance to increase the portion size of their meal for some small amount of money. This presents a curious problem for the concept of free will — the patron has already made a calculation about the amount of money they are willing to pay in return for a particular amount of food. However, when the question is re-asked, — not "Would you pay $5.79 for this total amount of food?" but "Would you pay an additional 30 cents for more french fries?" — patrons often say yes, despite having answered "No" moments before to an economically identical question.

Super-sizing is expressly designed to subvert conscious judgment, and it works. By re-framing

the question, fast food companies have found ways to take advantages of weaknesses in our analytical apparatus, weaknesses that are being documented daily in behavioral economics and evolutionary psychology.

This matters for more than just fat teenagers. Our legal, political, and economic systems, the mechanisms that run modern society, all assume that people are uniformly capable of consciously modulating their behaviors. As a result, we regard decisions they make as being valid, as with elections, and hold them responsible for actions they take, as in contract law or criminal trials. Then, in order to get around the fact that some people obviously *aren't* capable of consciously modulating their behavior, we carve out ad hoc exemptions. In U.S. criminal law, a 15 year old who commits a crime is treated differently than a 16 year old. A crime committed in the heat of the moment is treated specially. Some actions are not crimes because their perpetrator is judged mentally incapable, whether through developmental disabilities or other forms of legally defined insanity.

This theoretical divide, between the mass of people with a uniform amount of free will and a small set of exceptional individuals, has been broadly stable for centuries, in part because it was based on ignorance. As long as we were unable to locate any biological source of free will, treating the mass of people as if each of them had the same degree of control over their lives made perfect sense; no more refined judgments were possible. However, that binary notion of free will is being eroded as our understanding of the biological antecedents of behavior improves.

Consider laws concerning convicted pedophiles. Concern about their recidivism rate has led to the enactment of laws that restrict their freedom based on things they might do in the future, even though this expressly subverts the notion of free will in the judicial system. The formula here — heinousness of crime x likelihood of repeat offense — creates a new, non-insane class of criminals whose penalty is indexed to a perceived lack of control over themselves.

But pedophilia is not unique in it's measurably high recidivism rate. All rapists have higher than average recidivism rates. Thieves of all varieties are likelier to become repeat offenders if they have short time horizons or poor impulse control. Will we keep more kinds of criminals constrained after their formal sentence is served, as we become better able to measure the likely degree of control they have over their own future actions? How can we, if we are to preserve the idea of personal responsibility? How can we not, once we are able to quantify the risk?

Criminal law is just one area where our concept of free will is eroding. We know that men make more aggressive decisions after they have been shown pictures of attractive female faces. We know women are more likely to commit infidelity on days they are fertile. We know that patients committing involuntary physical actions routinely (and incorrectly) report that they decided to undertake those actions, in order to preserve their sense that they are in control. We know that people will drive across town to save $10 on a $50 appliance, but not on a $25,000 car. We know that the design of the ballot affects a voter's choices. And we are still in the early days of even understanding these effects, much less designing everything from sales strategies to drug compounds to target them.

Conscious self-modulation of behavior is a spectrum. We have treated it as a single property — you are either capable of free will, or you fall into an exceptional category — because we could not identify, measure, or manipulate the various components that go into such self-modulation. Those days are now ending, and everyone from advertisers to political consultants increasingly understands, in voluminous biological detail, how to manipulate consciousness in ways that weaken our notion of free will.

In the coming decades, our concept of free will, based as it is on ignorance of its actual mechanisms, will be destroyed by what we learn about the actual workings of the brain. We can wait for that collision, and decide what to do then, or we can begin thinking through what sort of legal, political, and economic systems we need in a world where our old conception of free will is rendered inoperable.

MICHAEL SHERMER
Publisher of *Skeptic* magazine, monthly columnist for *Scientific American; Author,* Science Friction

Where goods cross frontiers, armies won't

Where goods cross frontiers, armies won't. Restated: where economic borders are porous between two nations, political borders become impervious to armies.

Data from the new sciences of evolutionary economics, behavioral economics, and neuroeconomics reveals that when people are free to cooperate and trade (such as in game theory protocols) they establish trust that is reinforced through neural pathways that release such bonding hormones as oxytocin. Thus, modern biology reveals that where people are free to cooperate and trade they are less likely to fight and kill those with whom they are cooperating and trading.

My dangerous idea is a solution to what I call the “really hard problem”: *how best should we live?* My answer: A *free society,* defined as free-market economics and democratic politics — fiscal conservatism and social liberalism — which leads to the greatest liberty for the greatest number. Since humans are, by nature, tribal, the overall goal is to expand the concept of the tribe to include all members of the species into a global free society. Free trade between all peoples is the surest way to reach this goal.

People have a hard time accepting free market economics for the same reason they have a hard time accepting evolution: it is counterintuitive. Life looks intelligently designed, so our natural inclination is to infer that there must be an intelligent designer — a God. Similarly, the economy looks designed, so our natural inclination is to infer that we need a designer — a

Government. In fact, emergence and complexity theory explains how the principles of self-organization and emergence cause complex systems to arise from simple systems without a top-down designer.

Charles Darwin's *natural selection* is Adam Smith's *invisible hand*. Darwin showed how complex design and ecological balance were unintended consequences of individual competition among organisms. Smith showed how national wealth and social harmony were unintended consequences of individual competition among people. Nature's economy mirrors society's economy. Thus, integrating evolution and economics — what I call *evonomics* — reveals that an old economic doctrine is supported by modern biology.

ARNOLD TREHUB
Psychologist, University of Massachusetts, Amherst; Author, The Cognitive Brain

Modern science is a product of biology

The entire conceptual edifice of modern science is a product of biology. Even the most basic and profound ideas of science — think relativity, quantum theory, the theory of evolution — are generated and necessarily limited by the particular capacities of our human biology. This implies that the content and scope of scientific knowledge is not open-ended.

ROGER C. SCHANK
Psychologist & Computer Scientist; Chief Learning Officer, Trump University; Author, Making Minds Less Well Educated than Our Own

No More Teacher's Dirty Looks

After a natural disaster, the newscasters eventually excitedly announce that school is finally open so no matter what else is terrible where they live, the kids are going to school. I always feel sorry for the poor kids.

My dangerous idea is one that most people immediately reject without giving it serious thought: school is bad for kids — it makes them unhappy and as tests show — they don't

learn much.

When you listen to children talk about school you easily discover what they are thinking about in school: who likes them, who is being mean to them, how to improve their social ranking, how to get the teacher to treat them well and give them good grades.

Schools are structured today in much the same way as they have been for hundreds of years. And for hundreds of years philosophers and others have pointed out that school is really a bad idea:

We are shut up in schools and college recitation rooms for ten or fifteen years, and come out at last with a belly full of words and do not know a thing. — Ralph Waldo Emerson

Education is an admirable thing, but it is well to remember from time to time that nothing that is worth knowing can be taught. — Oscar Wilde

Schools should simply cease to exist as we know them. The Government needs to get out of the education business and stop thinking it knows what children should know and then testing them constantly to see if they regurgitate whatever they have just been spoon fed.

The Government is and always has been the problem in education:

If the government would make up its mind to require for every child a good education, it might save itself the trouble of providing one. It might leave to parents to obtain the education where and how they pleased, and content itself with helping to pay the school fees of the poorer classes of children, and defraying the entire school expenses of those who have no one else to pay for them. — JS Mill

First, God created idiots. That was just for practice. Then He created school boards. — Mark Twain

Schools need to be replaced by safe places where children can go to learn how to do things that they are interested in learning how to do. Their interests should guide their learning. The government's role should be to create places that are attractive to children and would cause them to want to go there.

Whence it comes to pass, that for not having chosen the right course, we often take very great pains, and consume a good part of our time in training up children to things, for which, by their natural constitution, they are totally unfit. — Montaigne

We had a President many years ago who understood what education is really for. Nowadays we have ones that make speeches about the Pythagorean Theorem when we are quite sure they don't know anything about any theorem.

There are two types of education. . . One should teach us how to make a living, And the other how to live. — John Adams

Over a million students have opted out of the existing school system and are now being home

schooled. The problem is that the states regulate home schooling and home schooling still looks an awful lot like school.

We need to stop producing a nation of stressed out students who learn how to please the teacher instead of pleasing themselves. We need to produce adults who love learning, not adults who avoid all learning because it reminds them of the horrors of school. We need to stop thinking that all children need to learn the same stuff. We need to create adults who can think for themselves and are not convinced about how to understand complex situations in simplistic terms that can be rendered in a sound bite.

Just call school off. Turn them all into apartment houses.

SUSAN BLACKMORE
Psychologist and Skeptic; Author, Consciousness: An Introduction

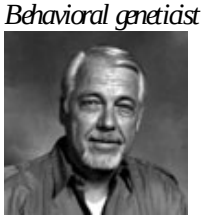
Everything is pointless

We humans can, and do, make up our own purposes, but ultimately the universe has none. All the wonderfully complex, and beautifully designed things we see around us were built by the same purposeless process — evolution by natural selection. This includes everything from microbes and elephants to skyscrapers and computers, and even our own inner selves.

People have (mostly) got used to the idea that living things were designed by natural selection, but they have more trouble accepting that human creativity is just the same process operating on memes instead of genes. It seems, they think, to take away uniqueness, individuality and "true creativity".

Of course it does nothing of the kind; each person is unique even if that uniqueness is explained by their particular combination of genes, memes and environment, rather than by an inner conscious self who is the fount of creativity.

DAVID LYKKEN
Behavioral geneticist and Emeritus Professor of Psychology, University of Minnesota; Author, Happiness



Laws requiring parental licensure

I believe that, during my grandchildren's lifetimes, the U.S. Supreme Court will find a way to approve laws requiring parental licensure.

Traditional societies in which children are socialized collectively, the method to which our species is evolutionarily adapted, have very little crime. In the modern U.S., the proportion of fatherless children, living with unmarried mothers, currently some 10 million in all, has increased more than 400% since 1960 while the violent crime rate rose 500% by 1994, before dipping slightly due to a delayed but equal increase in the number of prison inmates (from 240,000 to 1.4 million.) In 1990, across the 50 States, the correlation between the violent crime rate and the proportion of illegitimate births was 0.70.

About 70% of incarcerated delinquents, of teen-age pregnancies, of adolescent runaways, involve (I think result from) fatherless rearing. Because these frightening curves continue to accelerate, I believe we must eventually confront the need for parental licensure — you can't keep that newborn unless you are 21, married and self-supporting — not just for society's safety but so those babies will have a chance for life, liberty, and the pursuit of happiness.

CLIFFORD PICKOVER
Author, *Sex, Drugs, Einstein, and Elves*

We are all virtual

Our desire for entertaining virtual realities is increasing. As our understanding of the human brain also accelerates, we will create both imagined realities and a set of memories to support these simulacrums. For example, someday it will be possible to simulate your visit to the Middle Ages and, to make the experience realistic, we may wish to ensure that you *believe* yourself to actually be in the Middle Ages. False memories may be implanted, temporarily overriding your real memories. This should be easy to do in the future — given that we can already coax the mind to create richly detailed virtual worlds filled with ornate palaces and strange beings through the use of the drug DMT (dimethyltryptamine). In other words, the brains of people who take DMT appear to access a treasure chest of images and experience that typically include jeweled cities and temples, angelic beings, feline shapes, serpents, and shiny metals. When we understand the brain better, we will be able to safely generate more controlled visions.

Our brains are also capable of simulating complex worlds when we dream. For example, after I watched a movie about people on a coastal town during the time of the Renaissance, I was "transported" there later that night while in a dream. The mental simulation of the

Renaissance did not have to be perfect, and I'm sure that there were myriad flaws. However, during that dream I *believed* I was in the Renaissance.

If we understood the nature of how the mind induces the conviction of reality, even when strange, nonphysical events happen in the dreams, we could use this knowledge to *ensure* that your simulated trip to the Middle Ages seemed utterly real, even if the simulation was imperfect. It will be easy to create seemingly realistic virtual realities because we don't have to be perfect or even good with respect to the accuracy of our simulations in order to make them seem real. After all, our nightly dreams usually seem quite real even if upon awakening we realize that logical or structural inconsistencies existed in the dream.

In the future, for each of your own real lives, you will personally create ten simulated lives. Your day job is a computer programmer for IBM. However, after work, you'll be a knight with shining armor in the Middle Ages, attending lavish banquets, and smiling at wandering minstrels and beautiful princesses. The next night, you'll be in the Renaissance, living in your home on the Amalfi coast of Italy, enjoying a dinner of plover, pigeon, and heron.

If this ratio of one real life to ten simulated lives turned out to be representative of human experience, this means that right now, you only have a one in ten chance of being alive on the actual date of today.

JOHN ALLEN PAULOS
Professor of Mathematics, Temple University, Philadelphia; Author, A Mathematician Plays the Stock Market

The self is a conceptual chimera

Doubt that a supernatural being exists is banal, but the more radical doubt that we exist, at least as anything more than nominal, marginally integrated entities having convenient labels like "Myrtle" and "Oscar," is my candidate for Dangerous Idea. This is, of course, Hume's idea — and Buddha's as well — that the self is an ever-changing collection of beliefs, perceptions, and attitudes, that it is not an essential and persistent entity, but rather a conceptual chimera. If this belief ever became widely and viscerally felt throughout a society — whether because of advances in neurobiology, cognitive science, philosophical insights, or whatever — its effects on that society would be incalculable. (Or so this assemblage of beliefs, perceptions, and attitudes sometimes thinks.)

JAMES O'DONNELL
Classicist; Cultural Historian; Provost, Georgetown University; Author, Avatars of the Word

Marx was right: the "state" will evaporate and cease to have useful meaning as a form of human organization

From the earliest Babylonian and Chinese moments of "civilization", we have agreed that human affairs depend on an organizing power in the hands of a few people (usually with religious charisma to undergird their authority) who reside in a functionally central location. "Political science" assumes in its etymology the "polis" or city-state of Greece as the model for community and government.

But it is remarkable how little of human excellence and achievement has ever taken place in capital cities and around those elites, whose cultural history is one of self-mockery and implicit acceptance of the marginalization of the powerful. Borderlands and frontiers (and even suburbs) are where the action is.

But as long as technologies of transportation and military force emphasized geographic centralization and concentration of forces, the general or emperor or president in his capital with armies at his beck and call was the most obvious focus of power. Enlightened government constructed mechanisms to restrain and channel such centralized authority, but did not effectively challenge it.

So what advantage is there today to the nation state? Boundaries between states enshrine and exacerbate inequalities and prevent the free movement of peoples. Large and prosperous state and state-related organizations and locations attract the envy and hostility of others and are sitting duck targets for terrorist action. Technologies of communication and transportation now make geographically-defined communities increasingly irrelevant and provide the new elites and new entrepreneurs with ample opportunity to stand outside them. Economies construct themselves in spite of state management and money flees taxation as relentlessly as water follows gravity.

Who will undergo the greatest destabilization as the state evaporates and its artificial protections and obstacles disappear? The sooner it happens, the more likely it is to be the United States. The longer it takes ... well, perhaps the new Chinese empire isn't quite the landscape-dominating leviathan of the future that it wants to be. Perhaps in the end it will be Mao who was right, and a hundred flowers will bloom there.

PHILIP ZIMBARDO
Professor Emeritus of Psychology at Stanford University; Author: Shyness

The banality of evil is matched by the banality of heroism

Those people who become perpetrators of evil deeds and those who become perpetrators of heroic deeds are basically alike in being just ordinary, average people.

The banality of evil is matched by the banality of heroism. Both are not the consequence of dispositional tendencies, not special inner attributes of pathology or goodness residing within the human psyche or the human genome. Both emerge in particular situations at particular times when situational forces play a compelling role in moving individuals across the decisional line from inaction to action.

There is a decisive decisional moment when the individual is caught up in a vector of forces emanating from the behavioral context. Those forces combine to increase the probability of acting to harm others or acting to help others. That decision may not be consciously planned or taken mindfully, but impulsively driven by strong situational forces external to the person. Among those action vectors are group pressures and group identity, diffusion of responsibility, temporal focus on the immediate moment without entertaining costs and benefits in the future, among others.

The military police guards who abused prisoners at Abu Ghraib and the prison guards in my Stanford Prison experiment who abused their prisoners illustrate the "Lord of the Flies" temporary transition of ordinary individuals into perpetrators of evil. We set aside those whose evil behavior is enduring and extensive, such as tyrants like Idi Amin, Stalin and Hitler. Heroes of the moment are also contrasted with lifetime heroes.

The heroic action of Rosa Parks in a Southern bus, of Joe Darby in exposing the Abu Ghraib tortures, of NYC firefighters at the World Trade Center's disaster are acts of bravery at that time and place. The heroism of Mother Teresa, Nelson Mandela, and Gandhi is replete with valorous acts repeated over a lifetime. That chronic heroism is to acute heroism as valour is to bravery.

This view implies that any of us could as easily become heroes as perpetrators of evil depending on how we are impacted by situational forces. We then want to discover how to limit, constrain, and prevent those situational and systemic forces that propel some of us toward social pathology.

It is equally important for our society to foster the heroic imagination in our citizens by conveying the message that anyone is a hero-in-waiting who will be counted upon to do the right thing when the time comes to make the heroic decision to act to help or to act to prevent harm.

RICHARD FOREMAN
Founder & Director, Ontological-Hysteric Theater

Radicalized relativity

In my area of the arts and humanities, the most dangerous idea (and the one under who's influence I have operated throughout my artistic life) is the complete relativity of all positions and styles of procedure. The notion that there are no "absolutes" in art — and in the modern era, each valuable effort has been, in one way or another, the highlighting and glorification of elements previous "off limits" and rejected by the previous "classical" style.

Such a continual "reversal of values" has of course delivered us into the current post-post modern era, in which fragmentation, surface value and the complex weave of "sampling procedure" dominate, and "the center does not hold".

I realize that my own artistic efforts have, in a small way, contributed to the current aesthetic/ emotional environment in which the potential spiritual depth and complexity of evolved human consciousness is trumped by the bedazzling shuffle of the shards of inherited elements — never before as available to the collective consciousness. The resultant orientation towards "cultural relativity" in the arts certainly comes in part from the psychic re-orientation resulting from Einstein's bombshell dropped at the beginning of the last century.

This current "relativity" of all artistic, philosophical, and psychological values leaves the culture adrift, and yet there is no "going back" in spite of what conservative thinkers often recommend.

At the very moment of our cultural origin, we were warned against "eating from the tree of knowledge". Down through subsequent history, one thing has led to another, until now — here we are, sinking into the quicksand of the ever-accelerating reversal of each latest value (or artistic style). And yet — there are many artists, like myself, committed to the believe that — having been "thrown by history" into the dangerous trajectory initiated by the inaugural "eating from the tree of knowledge" (a perhaps "fatal curiosity" programmed into our genes) the only escape possible is to treat the quicksand of the present as a metaphorical "black hole" through which we must pass — indeed risking psychic destruction (or "banalization") — for the promise of emerging re-made, in new still unimaginable form, on the other side.

This is the "heroic wager" the serious "experimental" artist makes in living through the dangerous idea of radicalized relativity. It is ironic, of course, that many of our greatest scientists (not all of course) have little patience for the adventurous art of our times (post Stockhausen/ Boulez music, post Joyce/ Mallarme literature) and seem to believe that a return

to a safer "audience friendly" classical style is the only responsible method for today's artists.

Do they perhaps feel psychologically threatened by advanced styles that supercede previous principals of coherence? They are right to feel threatened by such dangerous advances into territory for which conscious sensibility if not yet fully prepared. Yet it is time for all serious minds to "bite the bullet" of such forays into the unknown world in which the dangerous quest for deeper knowledge leads scientist and artist alike.

JOHN GOTTMAN
Psychologist; Founder of Gottman Institute; Author, The Mathematics of Marriage

Emotional intelligence

The most dangerous idea I know of is emotional intelligence. Within the context of the cognitive neuroscience revolution in psychology, the focus on emotions is extraordinary. The over-arching idea that there is such a thing as emotional intelligence, that it has a neuroscience, that it is inter-personal, i.e., between two brains, rather than within one brain, are all quite revolutionary concepts about human psychology. I could go on. It is also a revolution in thinking about infancy, couples, family, adult development, aging, etc.

PIET HUT
Professor of Astrophysics, Institute for Advanced Study, Princeton

A radical reevaluuation of the character of time

Copernicus and Darwin took away our traditional place in the world and our traditional identity in the world. What traditional trait will be taken away from us next? My guess is that it will be the world itself.

We see the first few steps in that direction in the physics, mathematics and computer science of the twentieth century, from quantum mechanics to the results obtained by Gödel, Turing and others. The ontologies of our worlds, concrete as well as abstract, have already started to melt away.

The problem is that quantum entanglement and logical incompleteness lack the in-your-face quality of a spinning earth and our kinship with apes. We will have to wait for the ontology of the traditional world to unravel further, before the avant-garde insights will turn into a real revolution.

Copernicus upset the moral order, by dissolving the strict distinction between heaven and earth. Darwin did the same, by dissolving the strict distinction between humans and other animals. Could the next step be the dissolution of the strict distinction between reality and fiction?

For this to be shocking, it has to come in a scientifically respectable way, as a very precise and inescapable conclusion — it should have the technical strength of a body of knowledge like quantum mechanics, as opposed to collections of opinions on the level of cultural relativism.

Perhaps a radical reevaluation of the character of time will do it. In everyday experience, time flows, and we flow with it. In classical physics, time is frozen as part of a frozen spacetime picture. And there is, as yet, no agreed-upon interpretation of time in quantum mechanics.

What if a future scientific understanding of time would show all previous pictures to be wrong, and demonstrate that past and future and even the present do not exist? That stories woven around our individual personal history and future are all just wrong? Now that would be a dangerous idea.

DAN SPERBER
Social and cognitive scientist, CNRS, Paris; author, Explaining Culture

Culture is natural

A number of us — biologists, cognitive scientists, anthropologists or philosophers — have been trying to lay down the foundations for a truly naturalistic approach to culture. Sociobiologists and cultural ecologists have explored the idea that cultural behaviors are biological adaptations to be explained in terms of natural selection. Memeticists inspired by Richard Dawkins argue that cultural evolution is an autonomous Darwinian selection process merely enabled but not governed by biological evolution.

Evolutionary psychologists, Cavalli-Sforza, Feldman, Boyd and Richerson, and I are among those who, in different ways, argue for more complex interactions between biology and culture. These naturalistic approaches have been received not just with intellectual objections, but also with moral and political outrage: this is a dangerous idea, to be strenuously resisted, for it threatens humanistic values and sound social sciences.

When I am called a "reductionist", I take it as a misplaced compliment: a genuine reduction is a great scientific achievement, but, too bad, the naturalistic study of culture I advocate does not to reduce to that of biology or of psychology. When I am called a "positivist" (an insult among postmodernists), I acknowledge without any sense of guilt or inadequacy that indeed I don't believe that all facts are socially constructed. On the whole, having one's ideas described as "dangerous" is flattering.

Dangerous ideas are potentially important. Braving insults and misrepresentations in defending these ideas is noble. Many advocates of naturalistic approaches to culture see themselves as a group of free-thinking, deep-probing scholars besieged by bigots.

But wait a minute! Naturalistic approaches can be dangerous: after all, they have been. The use of biological evidence and arguments purported to show that there are profound natural inequalities among human "races", ethnic groups, or between women and men is only too well represented in the history of our disciplines. It is not good enough for us to point out (rightly) that 1) the science involved is bad science,
2) even if some natural inequality were established, it would not come near justifying any inequality in rights, and 3) postmodernists criticizing naturalism on political grounds should begin by rejecting Heidegger and other reactionaries in their pantheon who also have been accomplices of policies of discrimination. This is not enough because the racist and sexist uses of naturalism are not exactly unfortunate accidents.

Species evolve because of genetic differences among their members; therefore you cannot leave biological difference out of a biological approach. Luckily, it so happens that biological differences among humans are minor and don't produce sub-species or "races," and that human sexual dimorphism is relatively limited. In particular, all humans have mind/ brains made up of the same mechanisms, with just fine-tuning differences. (Think how very different all this would be if — however improbably — Neanderthals had survived and developed culturally like we did so that there really were different human "races").

Given what anthropologists have long called "the psychic unity of the human kind", the fundamental goal for a naturalistic approach is to explain how a common human nature — and not biological differences among humans — gives rise to such a diversity of languages, cultures, social organizations. Given the real and present danger of distortion and exploitation, it must be part of our agenda to take responsibility for the way this approach is understood by a wider public.

This, happily, has been done by a number of outstanding authors capable of explaining serious science to lay audiences, and who typically have made the effort of warning their readers against misuses of biology. So the danger is being averted, and let's just move on? No, we are not there yet, because the very necessity of popularizing the naturalistic approach and the very talent with which this is being done creates a new danger, that of arrogance.

We naturalists do have radical objections to what Leda Cosmides and John Tooby have called the "Standard Social Science Model." We have many insightful hypotheses and even some relevant data. The truth of the matter however is that naturalistic approaches to culture have

so far remained speculative, hardly beginning to throw light on just fragments of the extraordinarily wide range of detailed evidence accumulated by historians, anthropologists, sociologists and others. Many of those who find our ideas dangerous fear what they see as an imperialistic bid to take over their domain.

The bid would be unrealistic, and so is the fear. The real risk is different. The social sciences host a variety of approaches, which, with a few high profile exceptions, all contribute to our understanding of the domain. Even if it involves some reshuffling, a naturalistic approach should be seen as a particularly welcome and important addition. But naturalists full of grand claims and promises but with little interest in the competence accumulated by others are, if not exactly dangerous, at least much less useful than they should be, and the deeper challenge they present to social scientists' mental habits is less likely to be properly met.

MARTIN E.P. SELIGMAN
Psychologist, University of Pennsylvania, Author, Authentic Happiness

Relativism

In looking back over the scientific and artistic breakthroughs in the 20th century, there is a view that the great minds relativized the absolute. Did this go too far? Has relativism gotten to a point that it is dangerous to the scientific enterprise and to human well being?

The most visible person to say this is none other than Pope Benedict XVI in his denunciations of the "dictatorship of the relative." But worries about relativism are not only a matter of dispute in theology; there are parallel dissenters from the relative in science, in philosophy, in ethics, in mathematics, in anthropology, in sociology, in the humanities, in childrearing, and in evolutionary biology.

Here are some of the domains in which serious thinkers have worried about the overdoing of relativism:

• In philosophy of science, there is ongoing tension between the Kuhnians (science is about "paradigms," the fashions of the current discipline) and the realists (science is about finding the truth).

• In epistemology there is the dispute between the Tarskian correspondence theorists ("p" is true if p) versus two relativistic camps, the coherence theorists ("p" is true to the extent it coheres with what you already believe is true) and the pragmatic theory of truth ("p" is true if it gets you where you want to go).

• At the ethics/ science interface, there is the fact/ value dispute: that science must and should incorporate the values of the culture in which it arises versus the contention that science is and should be value free.

• In mathematics, Gödel's incompleteness proof was widely interpreted as showing that mathematics is relative; but Gödel, a Platonist, intended the proof to support the view that there are statements that could not be proved within the system that are true nevertheless. Einstein, similarly, believed that the theory of relativity was misconstrued in just the same way by the "man is the measure of all things" relativists.

• In the sociology of high accomplishment, Charles Murray (*Human Accomplishment*) documents that the highest accomplishments occur in cultures that believe in absolute truth, beauty, and goodness. The accomplishments, he contends, of cultures that do not believe in absolute beauty tend to be ugly, that do not belief in absolute goodness tend to be immoral, and that do not believe in absolute truth tend to be false.

• In anthropology, pre-Boasians believed that cultures were hierarchically ordered into savage, barbarian, and civilized, whereas much of modern anthropology holds that all social forms are equal. This is the intellectual basis of the sweeping cultural relativism that dominates the humanities in academia.

• In evolution, Robert Wright (like Aristotle) argues for a *scala naturae*, with the direction of evolution favoring complexity by its invisible hand; whereas Stephen Jay Gould argued that the fern is just as highly evolved as Homo sapiens. Does evolution have an absolute direction and are humans further along that trajectory than ferns?

• In child-rearing, much of twentieth century education was profoundly influenced by the "Summerhillians" who argued complete freedom produced the best children, whereas other schools of parenting, education, and therapy argue for disciplined, authoritative guidance.

• Even in literature, arguments over what should go into the canon revolve around the absolute-relative controversy.

• Ethical relativism and its opponents are all too obvious instances of this issue

I do not know if the dilemmas in these domains are only metaphorically parallel to one another. I do not know if illumination in one domain will not illuminate the others. But it might and it is just possible that the great minds of the twenty-first century will absolutize the relative.

HOWARD GARDNER
Psychologist, Harvard University; Author, Changing Minds

Following Sisyphus, not Pandora

According to myth, Pandora unleashed all evils upon the world; only hope remained inside the box. Hope for human survival and progress rests on two assumptions: (1) Human constructive tendencies can counter human destructive tendencies, and (2) Human beings can act on the basis of long-term considerations, rather than merely short-term needs and desires. My personal optimism, and my years of research on "good work", could not be sustained without these assumptions.

Yet I lay awake at night with the dangerous thought that pessimists may be right. For the first time in history — as far as we know! — we humans live in a world that we could completely destroy. The human destructive tendencies described in the past by Thomas Hobbes and Sigmund Freud, the "realist" picture of human beings embraced more recently by many sociobiologists, evolutionary psychologists, and game theorists might be correct; these tendencies could overwhelm any proclivities toward altruism, protection of the environment, control of weapons of destruction, progress in human relations, or seeking to become good ancestors. As one vivid data point: there are few signs that the unprecedented power possessed by the United States is being harnessed to positive ends.

Strictly speaking, what will happen to the species or the planet is not a question for scientific study or prediction. It is a question of probabilities, based on historical and cultural considerations, as well as our most accurate description of human nature(s). Yet, science (as reflected, for example, in contributions to Edge discussions) has recently invaded this territory with its assertions of a biologically-based human moral sense. Those who assert a human moral sense are wagering that, in the end, human beings will do the right thing. Of course, human beings have the capacities to make moral judgments — that is a mere truism. But my dangerous thought is that this moral sense is up for grabs — that it can be mobilized for destructive ends (one society's terrorist is another society's freedom fighter) or overwhelmed by other senses and other motivations, such as the quest for power, instant gratification, or annihilation of one's enemies.

I will continue to do what I can to encourage good work — in that sense, Pandoran hope remains. But I will not look upon science, technology, or religion to preserve life. Instead, I will follow Albert Camus' injunction, in his portrayal of another mythic figure endlessly attempting to push a rock up a hill: one should imagine Sisyphus happy.
